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NAVAL WAR COLLEGE
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Anti-Personnel Landmines: A Force Multiplier or an Operational Liability in the 21st Century

By

Alexander V. Martynenko
Lieutenant Colonel, United States Marine Corps

A paper submitted to the Faculty of the Naval War College in partial satisfaction of the requirements of the Department of Joint Military Operations.

The contents of this paper reflect my own personal views and are not necessarily endorsed by the Naval War College or the Department of the Navy.

Signature: Alexander V. Martynenko

18 May 2001

J. P. Edwards
Faculty Advisor
Captain J.P. Edwards, JAGC, USN

> An important part of my ability to meet the threat is the capability that I now have with anti-tank and anti-personnel landmines...If forced to fight without these weapons, Combined Forces Command will require additional force structure to offset the lost capability and we will take additional casualties.
>
> - General John H. Tilleli, Jr., U.S. Army, Ret. (Former CINC, CFC, Korea 1996-1999)[1]

> In consideration of the certain prospects of the flood of civilian refugees in this area, and the fluidity and rapid response needs of our own counter-attacking forces, the use of scatterable mines in Korea, "smart" or not, would be a game plan for disaster...Not only civilians, but U.S. armed forces, will benefit from the Ottawa Treaty's ban on APLs. U.S. forces in Korea are no exception.
>
> - Lieutenant General James F. Hollingsworth, U.S. Army, Ret. (Former I Corps Commander, Republic of Korea/US Army Group, 1973-1976), August 1997[2]

Such disparate views are reflective of the controversy that has beset U.S. political and military circles resulting from the Ottawa Process to ban landmines. Although these two opinions deal specifically with landmine use in the defense of South Korea, in general the debate centers on the issue of providing adequate force protection while minimizing indiscriminate attacks on non-combatants. Statistics reflect that an estimated 100 million anti-personnel landmines left from previous wars remain active in at least 70 countries and kill over 800 people every month. It is a problem of global proportion and the humanitarian interest it has generated has never had a more visible profile than it does today. At the forefront of the international movement to ban landmines is the 1997 Ottawa Treaty whereby member-states have agreed not to use or transfer anti-personnel landmines or to assist anyone with actions that are prohibited under its provisions. As of January 2001, 139 nations had signed the Treaty and of those 110 had further ratified it.[3] Conspicuously omitted from the list is the United States which has chosen not to sign the Treaty citing its unique responsibilities and security concerns that would be jeopardized under the constraints of the agreement. While retaining its right to use anti-personnel landmines (APLs) for the present the U.S. has nonetheless agreed to sign the Treaty by 2006 or sooner provided that suitable

alternatives to these weapon systems are identified. This study assumes that the new administration will also adopt this policy in light of its recent statements on the subject.[4]

The contentious debates over U.S. landmine policy indicate that it is a dynamic issue with many competing interests. The purpose of this paper is not to discuss the validity of the policy or its potential impact *vis-à-vis* other strategic arms control treaties. Nor is an examination of the relative merits of wargaming scenarios that have resulted in conflicting viewpoints regarding the continued military utility of this weapon appropriate to the scope of this discussion. Instead, the focus is at the operational level of war and those aspects of the landmine ban that are most pertinent to a combatant CINC. Specifically, this thesis looks to determine the operational implications for future U.S. coalition warfare resulting from the Ottawa Treaty. The relevance of this research rests in the premise that warfighters must understand the policy changes that impact the way in which they attempt to shape the battlefield.[5] To this end the study addresses several key areas for consideration: 1) What is the operational impact of the Ottawa Treaty (OT) for U.S. forces when participating in coalition operations? 2) What is the potential effect on overseas stocks of pre-positioned landmines if the U.S. complies with the OT? 3) What are the potential alternative technologies that could replace existing APLs? And 4) What are the immediate and long term requirements for a CINC in light of the OT?

The approach used in answering the thesis consists of three stages. The first part briefly examines the historical development of the landmine along with its types and categories in order to provide a common understanding for further discussion. The second stage looks at the genesis of the campaign to ban landmines, the key articles of the OT, and the formulation of U.S. landmine policy. The final stage analyzes the impact of the OT on

future U.S. military operations and explores both the immediate and long term options available to the CINC in fielding a substitute for the APL.

The evolution of landmine warfare began with the adaptation of commercial mining techniques for military purposes. The first known use of offensive mine warfare was by the Assyrian Army in 880 B.C. whose soldiers drove tunnels under or through the walled fortifications of their enemies in order to gain access to the interior (Appendix C). With the advent of black powder in Europe in the 14th century attacking armies were able to fill such mines with explosive charges detonating them to create a breach. Subsequently, new and more efficient technologies became available that resulted in more powerful explosives – nitrocellulose (1845), dynamite (1866), picric acid (1871), and TNT (1902).[6]

The first self-contained explosive APLs were employed by the Chinese against Kublai Khan's Mongol invaders in 1277. They were infrequently used, however, and soon faded into obscurity. Technological advances spawned by the industrial revolution caused the next significant leap in mine development. The American Civil War witnessed the use of both anti-personnel and anti-vehicular landmines on a grand scale, especially by the Confederacy in the defense of key southern cities. Interestingly, given this historical precedent for landmine warfare, along with improvements in mine lethality during the last half of the 19th century, these weapon systems were seldom used in World War I. Major William Schneck, USA, notes that "it was not until the Second World War that APLs reached full maturity, and they have been an important facet of almost every conflict since."[7]

The American experience in the Korean and Vietnam Wars caused yet another technological advancement in landmine warfare. In order to reduce the rising number of civilian casualties and to prevent the enemy from using U.S. mines against its own forces the

military began developing the "smart" mine - an electronically fused, blast-resistant, self-destructing mine (as opposed to the "dumb" mine - a simple pressure fused, non-destructing variant). Additionally, anti-handling devices (AHDs) were added to a percentage of its anti-tank mines as a counter to enemy breaching efforts (Appendix A). Currently, both "dumb" and "smart" APLs are found in the U.S. inventory. The former type, consisting of M14 and M16 mines, are now located only in Korea (estimated at one million). The "smart" mine makes up the bulk of the landmine stock and is comprised of five different series, commonly referred to as the Family of Scatterable Mines or FASCAM (Appendix B). The self-destruct function can be set for a period of from 4 hours to 15 days depending on the type of mine and how it is used. The mine is also equipped with a self-neutralizing capability that will render it ineffective after approximately 120 days (based on life expectancy of the internal battery) should the primary self-destruct mechanism fail. The reliability rate for self-destruction of these mines is purported to be at a whopping 99.99% though many doubt the accuracy of such estimates.[8]

FASCAM systems are either a pure-APL munition, i.e., the Area Denial Artillery Munition (ADAM) or a mixed variant consisting of both APL and anti-tank (AT) mines, i.e., Gator (CBU 78/89). In each case, the APL when delivered deploys trip wires in several directions and upon activation bounds like the M16 conventional mine inflicting casualties up to 10 meters away. It is important to note that the OT bans only APL munitions and not AT mines by themselves. However, because of the mixed nature of the Gator, Modular Pack Mine System (MOPMS) and Volcano systems these munitions would also be banned under the Treaty.[9]

The Ottawa Process emerged from the international movement to ban landmines that began in earnest during the 1980 Convention on Prohibitions of Restrictions on the Use of Certain Conventional Weapons Which May be Deemed to be Excessively Injurious or to Have Indiscriminate Effects. The Convention, usually referred to as the "Convention on Conventional Weapons" or "CCW" entered into force on 2 December 1983 with more than 50 signatories, including the U.S., and consisted of the main text and three attached protocols. Protocol II - The Landmine Protocol, specifically addressed the use and emplacement of landmines and booby-traps and is germane to the development of the OT. Although on the surface the CCW appeared to impose strict prohibitions on the use of APLs and booby-traps, in fact, the accord was fraught with various loopholes which gave armies broad latitude in conducting landmine warfare.[10] In his book The Technology of Killing, Eric Prokosch writes, "On the whole, Protocol II gives the impression of having been written to satisfy the needs of military forces, which may later have to occupy a mined area, rather than to protect civilians."[11]

Throughout the remainder of the decade the U.S. placed the APL issue on the political back burner (two presidential administrations failed to ratify the treaty) though this is not surprising given the turbulent events of that period. With the collapse of the Soviet Union the U.S. embarked on a new National Security Strategy of Engagement and Enlargement, with its emphasis on support to third world nations, that squarely brought the landmine dilemma back to the forefront. Consequently, the ban movement once again began to gain momentum primarily through the efforts of various Non-Governmental Organizations (NGOs), i.e., the International Campaign to Ban Landmines (ICBL) and members within the U.S. Congress, notably Senator Patrick Leahy (D-VT) and Representative Lane Evans (D-

IL). The military response in turn was simple and straightforward - its view was that responsible nations should not be precluded from using a weapon with a proven military utility at the expense of other less responsible countries. In the ensuing months both sides would continue to garner support for their respective positions each claiming the moral high ground - the activists would cite their humanitarian concern over the *indiscriminate* killings caused by APLs while the military countered with their need to provide adequate force protection especially in places like Korea.[12] Thus the stage was set for the final series of events that would lead to the 1997 Oslo Convention and Ottawa Treaty.

The failure of the first and second review conferences of the CCW to develop any meaningful provisions prohibiting landmine use prompted the Canadian government to sponsor a separate conference in Ottawa in October 1996 with the goal of "establishing a moral norm on APLs through a comprehensive ban on use, production, transfer, and the elimination of stockpiles."[13] Following this meeting, four additional diplomatic sessions were held concluding in Oslo, Norway during which the text of the Treaty was finalized. On 3 December 1997 the Ottawa Treaty was formally presented by the Canadian government and initially signed by 122 nations. It entered into force on 1 March 1999 with the ratification of the required 40th member-state (Appendix F).[14]

In summary, the Ottawa Treaty represents a major step forward in the international movement to ban APLs and purportedly provides the necessary strong language that had been lacking in earlier agreements. Art. 1 states:

> 1. Each State Party undertakes never under any circumstances:
> a) To use anti-personnel mines;
> b) To develop, produce, otherwise acquire, stockpile, retain or transfer to anyone, directly or indirectly, anti-personnel mines;
> c) To assist, encourage or induce, in any way, anyone to engage in any activity prohibited to a State Party under this Convention.

2. Each State Party undertakes to destroy or ensure the destruction of all anti-personnel mines in accordance with the provisions of this Convention.[15]

Additional significant aspects of the treaty include:

a) The destruction of all stockpiled APLs owned or possessed by a State Party within four years of its entry into force (Art. 4);
b) The destruction of all emplaced mines within ten years of its entry into force with a possibility for an extension for an additional ten years (Art. 5);
c) The adoption of national implementation measures, including penal sanctions, "to prevent and suppress any activity prohibited...under this Convention undertaken by persons or on territory under its jurisdiction or control" (Art. 9); and
d) The right to withdraw from the Convention upon providing a six month advance notification unless a Party is engaged in hostilities (in which case it may not withdraw before the end of the armed conflict) (Art. 20).[16]

In refusing to sign the OT, the U.S. had two fundamental concerns. The first was for the protection of its forces stationed in Korea that many claimed would be seriously threatened without a proven replacement to the current inventory of APLs. The second fear was that the Treaty would preclude the use of U.S. FASCAM systems because of their inherent construction.[17] These apprehensions were reflected in a series of Presidential Decision Directives (PDDs) that set forth U.S. APL policy. On 16 May 1996, President Clinton signed PDD 48 which stated, in part, that the U.S. would seek an international agreement to ban APLs. However, the PDD also indicated that the U.S. reserved its right to use such weapons in Korea stating that this was a "unique case." Additionally, the U.S. would unilaterally cease using and destroy its remaining stockpiles of "dumb" APLs (less those needed in Korea) and would also reserve its right to use "smart" mines until a viable alternative could be fielded. On 17 January 1997, the President refined his policy in promulgating PDD 54 which declared that the U.S. would seek a global ban on landmines at the upcoming United Nations Conference on Disarmament (CD) and would impose a

unilateral APL stockpile cap and permanent ban on APL transfers. The U.S. again voiced its sentiments during its participation at the Oslo Convention, 1-21 September 1997, proposing a number of modifications that would permit it to accept the accord . Unable to sign the OT "in good conscience," the President in May 1998 issued his final directive, PDD 64 (Appendix D).[18] Here the President stated that the U.S. would agree to sign the OT by 2006 if it could field a suitable alternative to its existing APLs and mixed AT/APL systems and would end the use of all APLs outside of Korea by 2003 including those that self-destruct (non self-destructing APLs less those in Korea would be destroyed by 1999).[19] As one would expect, ban activists considered this measure as a poor substitute for failing to sign the Treaty while the military proclaimed it to be a serious setback to its force protection efforts.

The U.S. has sought to deflect much of the growing international and domestic pressure through an ostensible commitment to sign the OT and an extensive global demining program - *Demining 2010,* in which it has invested over $500 million in the past several years. Clearly though, any future U.S. move with regard to changing its APL policy will continue to be tied to its view on the special importance of landmines in Korea.[20]

To the military, landmines have historically been a cost effective method of denying ground to the enemy. U.S. Mine Warfare Doctrine identifies four principle functions that landmines serve in counter-mobility operations: disruption of enemy formations and control, canalization of enemy forces, protection of friendly forces from enemy assault, and attrition of enemy personnel and equipment. Furthermore, in the offense landmine systems can be used to protect friendly flanks, block counterattack routes, contain enemy forces and block exit routes, and fix and hold bypassed enemy units.[21] In Korea, war plans call for laying an additional one million "dumb" mines in the event of a North Korean attack combined with

sowing large numbers of FASCAM minefields around advancing enemy forces and key targets within North Korea, i.e., artillery sites, fuel and ammo depots, etc. Military officials have been split in their opinion as to the validity of this strategy and the use of APLs in general. Most of the current leadership supports the U.S. policy but the list of those opposed to the continued use of APLs is formidable. Fourteen senior officers including General (Ret.) H. Norman Schwartzkopf, USA (former Commander, Desert Storm), General (Ret.) David Jones, USAF (former CJCS), and General (Ret.) John Galvin, USA (former SACEUR) testified that APLs no longer had any significant military role.[22] Former Marine Commandant General (Ret.) Al Gray, Jr. stated:

> I know of no situation in the Korean War, nor in the five years I served in Southeast Asia, nor in Panama, nor in Desert Storm where our use of mine warfare truly channelized the enemy and brought him into a destructive pattern...I'm not aware of any operational advantage from [the] broad deployment of mines.[23]

As noted earlier, this study does not aim to discuss the merits of either position as they relate to the Korean scenario. Exhaustive computer simulations have been conducted by a number of Department of Defense (DoD) agencies where they have concluded that removal of APLs would cause an increase in the number of allied casualties by upwards of 15% in a Persian Gulf conflict, 30% in Korea, and 35% in a European war (presumably against a Russian attack on Turkey). Ban activists in turn have been quick to point out various flaws in the assumptions and techniques used in the modeling, which they claim render the results inaccurate. Additionally, they cite several countermeasures the North Koreans could employ in breaching minefields similar to those used by U.S. forces in the Persian Gulf that would negate the effectiveness of APLs, i.e., Fuel Air Explosives (FAE), mine clearing rocket line charges (MICLIC), and armored mine plows. In its own review, the Institute for Defense

Analysis (IDA) concluded that the unpredictability of the conditions in future conflicts would render uncertain the consequences of a treaty with respect to U.S. casualties.[24] Yet beyond all of the debates and statistics looms the current policy that the U.S. will no longer employ pure-APLs outside of Korea as of 2003. This tends to create doubt as to whether the Korean Peninsula is indeed a special security consideration or if there is some other undisclosed reason for the continued use of this weapon in that theater.

The U.S. presently stands at a major crossroads in its APL policy and concept for future landmine warfare. The former administration committed the military to fielding a suitable replacement for its APLs and mixed AT/APL systems in an effort to sign the OT. Should the new administration choose to rescind PDD 64, or otherwise delay the removal of this weapon from the existing inventory, the military would be faced with a series of significant challenges in conducting future combined operations. This study now turns to an examination of the potential alternatives to APLs and an analysis of the implications of the OT on coalition warfare.

Recent advances in information systems and weapons technologies have made the thought of *discriminate* killing a distinct possibility in future conflicts. Microelectronics, lasers, focal-plane arrays, Global Positioning Systems (GPS), robotics, biotechnology, artificial intelligence, and digitization all have potential relevance and application to future landmine warfare. In some fields the U.S. already possesses the technology to replace APLs with both advanced unattended ground sensors to detect the enemy and less than lethal weapons to hinder or prevent his movement.[25] Research to develop alternatives to APLs has concentrated in several different areas, i.e., improved surveillance and target acquisition systems, command verification of targets when employing lethal weapons, and less than

lethal technology to include electromagnetic pulse (EMP) weapons. A few examples of each category follow with a more detailed illustration provided in Appendix E.

> *Improved Surveillance and Target Acquisition:*
> a) Robotic vehicles equipped with GPS, video cameras, laser ranging and a real-time communications link to a monitoring station and indirect fire control station. Advance models will have a limited firing capability and a self-destruct function to prevent capture.
> b) Advanced Unmanned Aerial Vehicles (UAV) with extended flight ranges and endurance along with the ability to hover or equipped with video cameras that allow the image to appear as if the UAV were stationary.
>
> *Command Verification Systems:*
> a) Intelligent Wide Attack Munitions such as the "Hornet" system that has built-in motion sensors that enable it to identify, track, and destroy armor and other vehicles by shooting an explosive penetrator through the top of the vehicle (currently under production for the U.S. Army).
> b) Advanced Claymore Mine System that would use wireless signals for command detonation.
>
> *Less than Lethal Technology:*
> a) A range of available technologies exist that could be fashioned into devices that would emit sticky foam and aerosol, rubber bullets, spray, or entangling materials when disturbed. The more advanced technologies deal with acoustic and radio frequency disabling systems.
> b) Electromagnetic Pulse (EMP) generator that could be used on the battlefield to disable and delay the enemy in completing its mission.[26]

A major concern of military planners has been that the removal of APLs would jeopardize U.S. AT mines because it would make it easier for the enemy to disable them. In reality removing APLs would only assist the enemy in clearing AT minefields if they were conducting manual breaching operations (the Pentagon estimates that the time it would take to clear a minefield would be reduced from 40 to 10 minutes, although the size of minefield is not given).[27] However, it must be noted that should the enemy employ FAE or MICLIC, all APL and AT munitions within the effective blast radius would be destroyed making the removal of the APL a moot point. A corollary argument with respect to mixed munitions also contends that removal of the APL component would render the whole FASCAM system

ineffective. Two points are worth mentioning in this regard. First, the APL munition of the mixed system is only one safeguard designed to prohibit or eliminate tampering of the AT mine. A percentage of AT rounds are fitted with AHDs which also inhibit enemy efforts at disarming. Thus by equipping a larger percentage of these rounds with AHDs it follows that one could achieve a greater degree of component security, but they would still be vulnerable to the same breaching techniques. Furthermore, while removing the APL component would certainly degrade the lethality of the mixed munition, such action would not render the system totally ineffective. Secondly, for the many merits of FASCAM there are also several significant shortcomings that detract from its overall effectiveness. These include: low minefield density to high basic load ratio (a 400 X 400 meter minefield requires 24 RAAM and 6 ADAM rounds), long firing time to emplace an artillery delivered minefield resulting in exposure to enemy counterbattery fire, and because they are surface laid they are easier to detect and counter than conventional mines.[28] Although a more detailed discussion in this area is beyond the scope of this study, the point made is that FASCAM may not be the panacea for future landmine warfare that many believe it to be.

Unquestionably, the debate over the military utility of landmines and the fielding of alternative technologies will only grow more contentious as the self-imposed deadline for elimination of APLs draws nearer. To date the Bush administration has not officially stated its position regarding PDD 64 nor what future action it may take should alternative systems not be fielded by 2006. In the event that it chooses to revoke the directive, and without having signed the OT, the U.S. military must be prepared to deal with a series of complex policy and operational planning problems.

The first of these deals with the continued stockpiling of U.S. APLs on the territory of allies who are parties to the Convention. In this area the military has four principle concerns:

1) Whether there is a destruction requirement for APLs owned by the United States but stored on the territory of a State Party;
2) Whether allowing a foreign-owned stockpile to exist on a State Party's territory would fall under the provision in paragraph 1(c) of the Treaty which prohibits parties from giving assistance, encouragement or inducement to countries using landmines;
3) Whether transfer requirements would preclude logistical cooperation regarding movement of munitions involving APLs to either areas of combat or other operations such as the ongoing United Nations (UN) peacekeeping operations in Bosnia; and
4) Whether APLs aboard pre-positioning ships, may transit the territory, including the ports, of State Party's without violating the Treaty?[29]

Answers to these questions depend on the interpretation of the language contained in paragraph 1(c) and in the definitions of the words "jurisdiction" or "control" found in Articles 4 and 5 of the Treaty.[30] Specifically, does permission by a signatory state to store APLs on its sovereign territory amount to "assisting, encouraging or otherwise inducing prohibitive acts" and therefore constitute a violation of the Treaty? Similarly, does storage imply that the granting party then has jurisdiction or control over such APLs (hence necessitating their destruction) even though they are the property of another state? In a worse case scenario, i.e., a narrow reading of the Treaty, the strategic implication of this restriction would mean that the U.S would be forced to remove its global stockpiles of APLs (Appendix B). It could also impact on the military's ability to offload these weapons from afloat pre-positioned ships onto the territory of member-states. Furthermore, since the Treaty prohibits the transfer of APLs they could not be routed from CONUS locations to the objective area through intermediate sea or air bases in participating countries. Instead, the weapons would have to be delivered directly to the battlefield complicating the overall logistics flow and

potentially jeopardizing the military's ability to respond quickly and effectively to an emerging crisis.[31]

A second major issue for U.S. officials is how the OT will impact on the military's ability to effectively conduct coalition operations at the operational and tactical levels with allies that are signatories to the Convention. Once again there is sufficient ambiguity in the wording of the Treaty that leaves the window for interpretation open (recall that Article 1 of the OT prohibits a state party from encouraging anyone from <u>using</u> APLs). In this instance the debate centers on the meaning of the word "use" as it pertains to APLs. Interestingly, the U.S. has defined the term as "the act of emplacement of landmines" and suggests that already deployed mines would not be technically in use, an understanding that was not given serious consideration in Oslo. At first glance it would appear that the intent of the U.S. was to secure wording in the Treaty that would protect its existing landmines in Korea, however this is unlikely as the government has sought specific exemption for this case under Art. 17.[32] A more logical conclusion is that the administration was hoping to generate a loophole whereby the U.S. would be able to employ its scatterable minefield systems in support of its allies (and thus itself) without those nations then being in violation of Art 1. Christian Capece notes that during the negotiations in Oslo some members suggested that "if a signatory receives a tactical benefit from a landmine then that would violate Article 1 regardless of who placed the mines" and would thus require that state to clear any U.S. mines in its respective zone.[33]

Opponents of the OT claim that this interpretation would seriously jeopardize the ability of U.S. forces to effectively fight <u>alongside</u> their coalition partners and may even preclude the latter's participation in an alliance with the U.S. based upon our use of

landmines. While their opinions certainly merit consideration these critics may be placing too much emphasis on only one type of weapons system that would be used in a defensive operation and neglecting others such as tactical airpower and precision guided munitions that worked so effectively against Iraqi armor in the Gulf War. Furthermore, this study concludes that it would be unlikely that a signatory state would forego conducting military operations with the U.S. solely on the ground that its mere participation could be construed as "assistance, encouragement, or inducement" under Art. 1(c).[34]

A final concern for operational planners stems from Article 9 and its requirement for member-states to develop national implementation measures to enforce the provisions of the Treaty. This section mandates that a state "take all appropriate legal, administrative and other measures, including the imposition of penal sanctions" to "prevent and suppress" any prohibited activity "undertaken by persons or on territory under its jurisdiction or control."[35] The immediate impact of such legislation would fall on U.S. APL stockpiles where we would be forced to either "move them or lose them." Should a crisis erupt and the U.S. choose to deploy APLs or mixed munitions on the soil of a signatory state then individual liability would also become an issue for military commanders and their forces. Additionally, this matter could find itself thrust into the arena of the proposed International Criminal Court (ICC) as several nations have suggested that landmine use is a crime of universal order and therefore should be prosecuted in an international legal forum. In this regard the U.S. is concerned that the vagaries in the legal definitions of crimes and the elements of those crimes that may be brought before the ICC would be detrimental to its interests. As David Scheffer, President Clinton's advisor on war crimes, noted in explaining the U.S. position: "...We have

to be careful that it [ICC] does not open up opportunities for endless frivolous complaints to be lodged against the United States as a global military power."[36]

Whether the ICC becomes a factor in the planning and execution of future U.S. military operations remains to be seen. The fact that this nation is not a party to the Convention will preclude its service members from being tried in the international court for violating the Treaty in general. Nonetheless, military commanders must be aware that their personnel may still be subject to punitive action for violating the domestic laws of member-states dealing with those activities prohibited by the Convention in the absence of a Status of Forces Agreement granting immunity for acts done pursuant to official duty.[37]

What then are the future strategic and operational consequences for the U.S. under its current APL policy embodied in PDD 64? Today the U.S. stands alone as a global superpower, capable of effectively defending its national interests through the employment of a highly skilled and technologically superior military. It has an unparalleled arsenal of sophisticated weapons and C4ISR systems that enable it to detect, identify, target and engage an enemy with near precision. Yet this preeminent force is also seen by many to be holding on to a weapon that kills indiscriminately while it professes to support the international humanitarian effort to ban APLs. Setting aside the wargaming statistics generated by both opponents and supporters of the OT, as well as the argument that the ban does nothing to rid the world of the millions of landmines already in place, the fundamental issue for policy makers is whether the U.S. can stay the current course given the growing number of nations to ratify the Treaty. Any such decision will always be a value judgement in balancing humanitarian responsibilities with the ever-present need to provide adequate force protection measures. In terms of a strategy-policy match it must be an attempt to harmonize military

necessities with political imperatives. This study, however, has intentionally avoided making its own recommendation as to whether the U.S. should sign the OT because it is not germane to the focus of its thesis - this is left to the reader to decide. Instead, the research has centered on examining specific provisions of the OT and other relevant legislation as they affect U.S. APL policy, identifying current landmine capabilities and alternative technologies, and looking at the significant operational implications stemming from the Treaty in order to provide an educated and unbiased summary of the topic.

In conclusion, assuming that the current U.S. APL policy will remain in effect and that alternative technologies are not fielded by 2006, what immediate and long term courses of action are available to a CINC to offset the operational liabilities noted earlier? Fixing the inventory of mixed munitions by removing the APL component and subsequently equipping each AT round with an AHD would be the leading requirement. Although this would no doubt be a costly and time consuming process it would solve both the problems of pre-positioning and use under the constraints of the OT. The second immediate requirement would be to enhance our inventory of command detonated APLs with a remote firing capability using wireless signals for increased standoff detonation. Lastly, existing less than lethal weapons systems should be configured in a manner to be employed as APLs and immediately fielded to frontline units. Additionally, advanced silent alarm sensor systems must be provided to our forces to aid them in protection against infiltration.[38]

For the long term the CINC should use his influence in the procurement of alternative technologies via the Joint Requirements Oversight Council (JROC) to speed research, evaluation and fielding of suitable APL replacements. Secondly, he should assist service components in the ongoing development of new landmine warfare doctrine and training that

incorporates the mandates of the current APL policy. And most importantly, he should continue to refine concept plans and operations plans that support both unilateral U.S use of APLs as well as those that preclude their employment in a coalition action. In the end, however, whatever course a CINC may take with regard to this most contentious issue will no doubt be predicated on whether <u>he</u> believes anti-personnel landmines are a true force multiplier on the modern battlefield or in fact only an operational liability in the 21^{st} Century.

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[2] James F. Hollingsworth, quoted in Demilitarization for Democracy, Exploding the Landmine Myth in Korea (Washington, D.C.: 1997), i-ii.
[3] Jane's Intelligence Review, Legislation and the Landmine (Special Report No. 16. Surrey, UK: 1997), 3; John. V. Klemencic, "United States Policy for Anti-Personnel Landmines," (Unpublished Research Paper, U.S. Army War College, Carlisle Barracks, PA: 1998), 1; United Nations: Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Anti-Personnel Mines and on their Destruction. American Society of International Law, International Legal Materials, Volume 36, Number 6 (Washington, D.C.: 1997) 1510; Landmine Survivors Network, "Ottawa Treaty Signatories, Convention on the Prohibition of the Use, Stockpiling, Product Transfer of Anti-Personnel Mines and on their Destruction." Concluded Oslo on 18 September 1997. <http://www.landminesurvivors.org/services/ottawasign.php3> [24 April 2001], 1.
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[5] Gregory L. Bier, "Anti-Personnel Landmine Policy and Implications," Engineer, Volume 28 PB 5-98-2 (April 1998): 27.
[6] Jon N.Jones, "United States Army Operations Under the Ottawa Convention:n Mine Warfare Without Anti-Personnel Landmines," (Unpublished Research Paper, U.S. Army Command And General Staff College, Ft. Leavenworth, KS: 1999), 1-2; William C. Schneck, "The Origins of Military Mines: Part I," Engineer, Volume 28 PB 5-98-3 (July 1998): 49-51.
[7] Jones, pg. 2; Schneck. The Origins of Military Mines: Part 1, 52.
[8] "Legislation and the Landmine," 15; Klemencic, 2-4; Weddle, 12-13.
[9] Jones, .53-54.
[10] Kemp L. Chester, "Influence and Outcome: The Making of a US Policy on Anti-Personnel Landmines," (Unpublished Research Paper, University of South Carolina, Columbia, SC: 1999), 15-16; David E. Funk, "A Mine is a Terrible Thing to Waste: The Operational Implications of Banning Anti-Personnel Landmines," (Unpublished Research Paper, U.S. Army War College, Carlisle, PA: 1998), 9; Nicola Short, "A Review of the Ottawa Process to Ban Landmines," November 1997. Lkd. The International Security Information Service at "Columbia International Affairs Online." http://wwwc.cc.columbia.edu/sec/dlc/ciao/wps/shn01 [March 1999],2.
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[12] Funk, 10-12.
[13] Short, 2.
[14] Funk, 16; "Ottawa Treaty Signatories, Convention on the Prohibition of the Use, Stockpiling, Product Transfer of Anti-Personnel Mines and on their Destruction." 4; Short, 2.
[15] I.L.M., 1510; Short, 7-8.
[16] I.L.M., 1510-1519; Short, 8.
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[19] "PDD 64," 1.
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[21] "Legislation and the Landmine," 13; Mark T. Kimmitt, "Rethinking FASCAM – Principles for the Use of Artillery Delivered Mines," (Unpublished Research Paper, School of Advanced Military Studies, U.S. Army

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[23] "Exploding the Landmine Myth in Korea," 15-16.

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[27] "Exploding the Landmine Myth in Korea," 11-14.

[28] Kimmett, 17-31.

[29] Christian M. Capece, "The Ottawa Treaty and its Impact on U.S. Military Policy and Planning," Brooklyn Journal of International Law, Vol. XXV:1 (1999): 191.

[30] Ibid., pg. 191.

[31] Capece, 189-193; Weddle, 15-16.

[32] Capece, 199-200; Short, 6.

[33] Capece, 200.

[34] Ibid., 200-201.

[35] I.L.M., 1515.

[36] Capece, 201-202.

[37] Ibid., 202-203.

[38] Jones, 85.

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Appendix A – General Information on U.S. Anti-Personnel Landmines

Landmines are classified by the function they are designed to perform: anti-personnel or anti-tank. They may best be characterized by their mode of operation and activation, the method of deployment, internal anti-handling devices, longevity, or a combination of those characteristics.

Classification

Anti-personnel: A mine designed to cause casualties to personnel.
Anti-tank: A mine designed to immobilize or destroy a tank.

Mode of Operation

Blast: A blast is a wave of air driven at ballistic speed from the site of the explosion. A blast mine is one from which the blast effect of the explosive content of the mine is the primary cause of injuries or damage sustained by the victim or target.
Fragmentation: A fragmentation mine contains an internal packing of fragments, usually metallic, or a segmented outer casing designed to break into fragments. When dispersed at ballistic speeds by the force of the explosion the main cause of injury to the victim, or damage to the target, is a result of being struct by those fragments.
Bounding: A bounding mine, usually of the anti-personnel fragmentation type, employs a primary charge designed to lift the mine to a predetermined height (normally 1-2 meters) before the main charge in initiated. Most bounding mines are activated by tripwire.

Type of Activation Mechanism

Pressure: A mine which is activated by direct pressure from above. Most anti-tank and many anti-personnel mines employ this method of activation.
Tripwire: A tripwire-activated mine has a wire or filament attached to a pull switch on the mine which causes the mine to detonate when a predetermined load is placed on the tripwire. The other end of the tripwire extends to a fixed object, often a metal stake driven into the ground or, in some cases, another mine. Some mines may have more than one tripwire.
Pressure release: A comparatively rare type of activation where the mine is detonated when a preapplied source of pressure is removed from the mine. Most commonly used as an anti-lift device when placed under an anti-tank mine or as a boobytrap.
Proximity: Some mines can be equipped with a fuse which detonates the mine when a victim or target passes within a predetermined distance of the mine.
Remote firing: Some mines, notably those designed to disperse fragmentation over a set field of effect – known as directional or ambush mines, can be activated by a pull wire or a similar device or may employ radio signal or other remote firing methods. The mine is fired from an observation point. Most such mines can also be activated by means of a tripwire as above.

Anti-handling Devices

Anti-lift device: A device arranged to detonate the mine to which it is attached, or to detonate another mine or charge nearby, if the mine is disturbed.

Anti-disturbance device: A device designed to detonate the mine to which it is attached if the mine is disturbed.

Deployment Method

Hand emplacement: Most mines can be hand emplaced. Pressure mines are normally buried just below the surface or camouflaged.
Mechanical emplacement: Some anti-tank and anti-personnel mines, usually pressure mines, can be buried or surface laid by purpose-designed mine-laying machinery.
Remote deployment: Most modern anti-personnel mines and many anti-tank mines are designed to be disseminated by remote means. They may be free-fall air-delivered, either directly from pods or carriers on fixed-wing aircraft or helicopters. They may be part of a cluster bomb system or be carried to the vicinity of their target area in artillery carrier rounds, or by rocket or mortar fire. Some mines may be sown from ground-based systems mounted on tracked or wheeled vehicles. All mines deployed by these methods will lie on the surface of the ground but may be difficult to see due to camouflage and clouring of the mine and, in some cases, by the irregular shape of the outer casing.
Scatterable: Scatterable mines are remotely delivered, normally from aircraft, and are designed to disperse over a wide area after release, normally due to the incorporation of wings or fins into the casing design.

Longevity

Non self-destructing: Mines with an indefinite duration of arming and activation.
Self-destructing: Mines with an internal capability to self-detonate after a designated time period usually from 4 hours to 15 days.
Self-neutralizing: Mines with a capability to self-deactivate when the internal battery expires after no more than 90 days.[1]

[1]May, 5; Rae. McGrath, Landmines and Unexploded Ordnance: A Resource Book (Sterling, Virginia: Pluto Press, 2000) 17-19; C.E.E. Sloan, Mine Warfare on Land (McLean, Virginia: Pergamon-Brassey's International Defense Publishers, 1986) 133-134.

Appendix B – U.S. Anti-Personnel Landmines

Mine	Type	Fuzing	Force to Detonate	Warhead	AHD	Shape	Height	Width	Weight
M14	AP	Pressure	25 lbs	Blast	No	Cylinder	1.56 in.	2.19 in.	3.3 oz.
M16A2	AP	Pressure TripWire	8 lbs	Bounding Frag	No	Cylinder	4.7 in.	4 in.	8 lb.
M18A1	AP	Command Trip Wire	NA	Directional Frag	No	Curved Block	approx. 4 in	approx. 6 in.	3.5 lb.

Characteristics of U.S. Conventional AP Mines[1]

Mine	Delivery System	Fuzing	Warhead	AHD	Self-destruct time	Shape
M72	155mm Artillery	Tripwire	Bounding Frag	20%	48 hr	Wedge
M67	155mm Artillery	Tripwire	Bounding Frag	20%	4 hr	Wedge
M74	MOPMS	Tripwire	Blast Fragment	No	4 hr (4 times)	Cylinder
Volcano	Ground/ Air	Tripwire	Blast Fragment	No	4/48 hr 15 days	Cylinder
M86	Manual	Tripwire	Bounding Frag	All	4 hr	Wedge

Characteristics of U.S. Scatterable AP Mines[2]

[1] Mahoney, 12.
[2] Ibid., 15.

"SMART" Landmines (Self-Destructing)

Area Denial Artillery Munition (ADAM): Artillery Delivered (155mm), 36 APL in each shell, 9,720,000 mines stockpiled.

M87: Mixed AT/AP system, delivered by Volcano system, 100,000 canisters stockpiled.

Modular Packed Mine System (MOPMS): Man portable, mixed AT/AP system, 2,000 stockpiled.

Pursuit Deterrent Munition (PDM): Hand emplaced, 16,000 mines stockpiled.

Gator Mine (CBU78/89): Air delivered, mixed AT/AP system, 14,300 stockpiled

"DUMB" (Non Self-Destructing)

M14 / M16: Man triggered, located only in Korea and Cuba. Total number in Korea is classified, but is in excess of 1 million. Mines in Cuba are being removed at this time.

U.S. Anti-Personnel Landmines[1]

Type of Landmine	*Location*
M68 Practice, M74 GEMSS (Ground-Emplaced Mine-Scattering System), ADAM, M131 MOPMS, Volcano	Germany
ADAM, Volcano, M-16, Gator	Japan
M74 GEMSS, ADAM, M131 MOPMS, Gator	Italy
M692E1, ADAM	Norway
M16, ADAM, Gator	Spain
ADAM, MOPMS, GEMMS, Volcano, Gator	United Kingdom (Diego Garcia)

Stockpiles and their locations in those countries that have signed the Ottawa Treaty as of Oct. 14, 1997[2]

[1] Klemencic, 3.
[2] Capece, 193.

Appendix C – Origin of Countermobility Equipment

Mine/Fuze Type	First Prototype	First Production	First Combat Use
Tunnel mining			Assyria, ~1000 BC
Caltrops			Greece, 330 BC
Explosive tunnel mines			Florence, 1403
Self-contained AP mine	China, 1277	China, 1277	China, 1277
Electric command- detonated mine	France, 1858		France, Sevastopol, 1858
Blast AT Mine	Germany, 1917	Germany, 1918	Germany, Western Front, 1917
Bounding AP mine	U.S., 1859	Germany, 1930s	Germany, West Wall, 1939
Chemical mine	U.K.	Germany, WWII	
Flame mine	Confederacy, 1864[1]	U.S.S.R., 1943	U.S.S.R., Kursk, 1943
Mechanical boobytraps	China, 1277	Confederacy, 1864[1]	China, 1277
Side-attack AT mine	Germany, 1943	U.S.S.R., 1943	Germany, Eastern Front, 1943
Full-width-attack AT mine	Germany, 1945	France, 1948	
Fixed-wing aircraft- scattered AP mine	Germany, 1930s	Germany, 1930s	Germany, Polish Campaign, 1939
Fixed-wing aircraft- scattered AT mine	U.S.	U.S., 1960s	U.S., Southeast Asia, 1960s
Helicopter-scattered AP mine	U.S., Vietnam	U.S.S.R., 1970s	U.S.S.R., Afghanistan, 1980s
Helicopter-scattered AT mine	U.S., 1970s	U.S., 1975	USSR, Afghanistan, 1980s
Tube artillery-scattered mines	U.S., 1970s	U.S., 1970s	U.S., Gulf War, 1991
Rocket artillery-scattered mines	U.S.S.R., 1970s		U.S.S.R., Afghanistan, 1980s
Vehicle-scattered mines		U.S., 1970s	
Manpack-scattered mines		U.S., 1990s	
Radio-controlled mines		U.S.S.R., 1941	U.S.S.R., 1942
Tilt-rod fuze		U.S.S.R., 1941	U.S.S.R., 1941
Daisy-chained mines	Finland, 1939		Finland, 1939
Coupled mines	Germany, 1942	Germany, WWII	Germany, North Africa, 1942
Boosted mines	Germany, 1942		Germany, North Africa, 1942
Breakwire fuze		U.S., 1960s	U.S.S.R., Afghanistan
Tripwire fuze	Germany, 1573	Germany, 1939	Germany, 1500s (?)
Railroad mine	Confederacy, 1862[1]	Germany, WWII	Confederacy, Civil War, 1862[1]
Electronic boobytrap		Yugoslavia, 1980s	Yugoslavia, 1990s
Low-metal mine		Finland, 1939	Finland, 1939
Influence fuze		U.S.S.R., WWII	U.S.S.R., WWII
Antihandling devices		Germany, 1930s	Germany, WWII
Mechanical mine planter	Germany, WWII	U.S.S.R., post-WWII	
Blast-hardened mines		Italy, 1980s	Mujahideen, Afghanistan, 1980s
Antihelicopter mine	Viet Cong, Vietnam War		Viet Cong, Vietnam War
Integral electronic antihandling device		Italy, 1980	

[1]Confederate States of America, 1861-65.

Origin of Countermobility Equipment[1]

[1] William C. Schneck, "The Origins of Military Mines: Part II." Engineer, Volume 28 PB 5-98-4 (November 1998): 46.

Humanitarian Demining Presidential Decision Directive PDD 64 (May 1998)[1]

- The United States will destroy by 1999 all of its non-self-destructing APL's except those needed for Korea.
- The United States will end the use of all APL's outside Korea by 2003, including those that self-destruct.
- The United States will aggressively pursue the objective of having APL alternatives ready for Korea by 2006, including those that self-destruct.
- The United States will search aggressively for alternatives to our mixed anti-tank systems by (a) actively exploring the use of APL alternatives in place of the self-destructing anti-personnel submunitions currently used in our mixed systems and (b) exploring the development of other technologies and/or operational concepts that result in alternatives that would enable us to eliminate our mixed systems entirely.
- The United States will sign the Ottawa Convention by 2006 if efforts succeed to identify and field suitable alternatives to US anti-personnel landmines and mixed anti-tank systems by then.

No text or factsheet for this PDD has been released. The foregoing highlights of PDD 64 were explicated in a 15 May 1998 letter from NSC Advisor Samuel "Sandy" Berger to Senator Patrick Leahy (D-VT).

[1] "PDD 64" 1.

Robotic Sensor and Attack Vehicle[1]

[1] Steve Douglas and others, Appendix A (Section A-1)

Sandia LabNews

February 2,1995

SARGE robot performs soldiers' duties without the risks

Sandia produces capable, adaptable battlefield prototype

By Philip Higgs, Lab News Intern

(back to Lab News contents page)

For years, both the Army and the Marines have been seeking to develop robots designed for the battlefield, machines that could perform all the dangerous duties of a soldier without all the risk.

"Using robots in war?" you might say. "Yeah, right. A robot could never replace a soldier."

You haven't met SARGE.

TEARING AROUND THE TRACK - SARGE was shipped to the Army/Marine Joint Programs Office in 1995, but engineer Bryan Pletta (5516) still uses its predecessor, Dixie, to run tests on the Robotic Vehicle Range track southeast of Area 1. Six years of experience with Dixie led designers to create a more adaptable, more capable robot with SARGE. (Photo by Randy Montoya) (Click on image for page containing larger view)

SARGE, the Surveillance And Reconnaissance Ground Equipment developed at Sandia's Advanced Vehicle Development Dept. 5516, is the latest standard in a long line of prototype battlefield robots. SARGE is a direct descendent of Sandia's Dixie robot, which was developed in the 1980s.

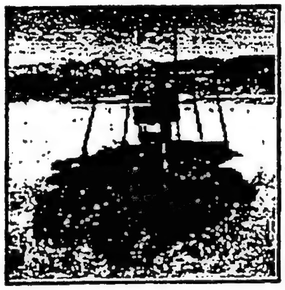
Battlefield tricks

This is no Hollywood robot - a walking, talking, metal humanoid with lasers for eyes, preprogrammed to destroy. Not SARGE. The current mission of battlefield robotics, handed down from the Department of Defense, calls for a much simpler machine, one that would be primarily engaged in remote surveillance.

SARGE and its predecessors have all been four-wheeled, remote-controlled vehicles - not a humanoid part on them. SARGE uses a commercial recreational "four-wheeler," a Yamaha Breeze, as its base platform. A roll cage has been added, and four video cameras, two for surveillance and two for driving, are attached to a pan/tilt platform.

Everything - steering, throttle, cameras - can be operated (or teleoperated) from an operational control unit (OCU) miles away.

Picture this battlefield scene: The enemy lies over a hill, three miles away from your battalion. The sergeant points a finger at you and three others and tells you to check out the situation. M-16s in hand, you head off toward the hill. Halfway there, 10 enemy soldiers spring from nowhere, aiming their rifles at your heads. What happens now?



BEFORE ITS completion in April 1995, SARGE was put through over 75 hours of testing. Here it pauses for a quick photo near the Robotic Vehicle Range. (Click on image for page containing larger view)

Or, picture this: You've been selected for the same mission. Instead of grabbing your M-16, you pull out the OCU for your battalion's SARGE unit and send the robot toward the hill, using its cameras to scope out the situation.

Any number of things might happen now, but one thing is for sure: the number of casualties will be less than one.

The SARGE project is not seeking to replace infantry soldiers. The Army and Marines want to use robotics to complement a soldier's abilities, not usurp them. "Obviously, using a robot for surveillance is different from using a person," says SARGE project manager Bryan Pletta (5516). "It's not going be as good at some things as a person would be, with eyes and ears and a brain. But it doesn't get tired, it doesn't get hungry, it doesn't get sleepy - and it's expendable."

A bit of history

SARGE is a prototype of what will eventually be standard battlefield equipment that will serve as a "force multiplier," something to increase soldier/Marine effectiveness and survivability - known in military jargon as a Teleoperated Unmanned Ground Vehicle (TUGV).

The final, complete TUGV system is expected to be produced in quantity and put into the armed forces inventory. Individual or multiple robots will be assigned to infantry units and battalions.

The TUGV (or "tug-vee," as they say) program was born of a curious union between the Army and the Marine Corps that began in the late 1980s.

Prior to 1988, both services were working separately on two different robot prototypes. DoD realized that the work of the two branches was parallel, and formed the Unmanned Ground Vehicles/Systems Joint Project Office (UGV/S JPO) in 1988 to consolidate their efforts.

Several attempts were made to develop a prototype robot that could be used for reconnaissance missions.

The first was the creation of the Teleoperated Mobile All-purpose Platform (TMAP) that would be adaptable to a number of different missions. Two versions of the TMAP system were developed, but neither was very popular with users.

The next generation in the development cycle was the Surrogate Teleoperated Vehicle (STV).

The STV also failed to live up to the lofty expectations of the military user. Problems with stability and communications prevented the system from gaining acceptance.

So out went the STV, and in came Dixie.

Dixie was popular

According to Bryan, during all of this early testing, "people were coming out and touring our range. A lot of these users had seen Dixie, and they really liked it. They thought it was easy to operate, it didn't turn over easily, it was relatively reliable, and they told the JPO, 'We want something like Dixie. We don't want this STV; we want Dixie.' "

The subsequent request that came out of the Army "specifically asked for a robot like Sandia Labs' Dixie," says Bryan. But by this time Dixie was about six years old, and those involved felt that a number of improvements were necessary.

"We told the JPO that we weren't going to build them Dixie, but something better," Bryan recalls. And thus, the SARGE project was born.

"Dixie far out-performed what was expected of her," says Tom Mayer (5516), a SARGE engineer. "But SARGE gave us the chance to rebuild Dixie from the ground up."

SARGE is equipped with four video cameras in accord with the JPO's current mission of Reconnaissance, Surveillance, and Target Acquisition (RSTA), but also has built-in expansion capabilities to interface with new mission modules as they are developed.

"You could put on a chemical detector, for instance, or a laser designator," says Bryan.

"The key was to provide a system where users could specify what they wanted, and SARGE would be able to handle it."

Gaining acceptance

Another key to the SARGE project is gaining acceptance from its users - the soldiers. "We've taken robots out to demonstrations, and most people like them," says Bryan. But there's one problem. "There's a lot of excitement in some areas of DoD for using robotics with different applications. Most of that is in the project offices or at the higher levels of the military. If you ask an infantry soldier if he likes this idea, more than likely he'll tell you no.

"Right now, using robotics is a pretty radical departure from the way they currently do things," he says.

With SARGE, however, the JPO is taking a new slant in research and development of the final TUGV by getting soldiers' hands on what would essentially be a soldier's tool.

A critical part of the project is the manufacture of eight to ten SARGE units to be given to infantry battalions, getting them involved in SARGE's development up front.

"The program will actually give them to infantry battalions and say, 'This is yours, keep it. Take it home, learn how to use it. Try and figure out what you could do with it if you had one,' " Bryan says.

The JPO is currently under contract with SUMMA Technologies Inc. to build the new units, with Sandia operating as technical adviser.

Obviously, without currently fielded systems, the Army and Marines have no doctrine, no guide, no established practice for using robots. Part of the evaluation process is having the soldiers themselves discover what can be done with such a robot, and developing tactics as they put them to use.

Soldier feedback will also be used to guide subsequent phases of TUGV development.

According to its creators, SARGE is easy to use. With motorcycle-like driving controls and joystick camera controls on a compact OCU the size of a suitcase, the robot is advertised as "user-friendly."

"The neat thing about SARGE is putting someone on it who's never used it before," says Tom. "It takes about two minutes to be comfortable with it. And that's the whole point: getting it as close as we can to the perfect extension."

SARGE offers quicker response time

The design criteria for Dixie were low power and low cost, both of which were achieved. Dixie was completed in 1988, when computers were a lot slower than they are now.

Dixie is teleoperated from its Operational Control Unit (OCU) via a 1200-baud radio link, and this, coupled with the slow speed of its processor, causes a 75-millisecond (ms) delay between user command and machine response.

Which is to say Dixie is a little slow when compared to modern counterparts.

"With Dixie, you have to 'drive ahead,' " says Tom. "You have to watch where you're going and plan for what's coming up because of the delay.

"With SARGE, the goal was to match teleoperation to actual use," which meant decreasing that 75-ms lag time.

"We wanted to make it seem like the user was right on top of the machine," he says, "and I think we came pretty close."

Pretty close, indeed. On SARGE, the command/response delay is approximately 20 ms, thanks to its much faster modern processors and communications equipment.

The base platform was also upgraded. Dixie was built on a Honda 125, which relied solely on balloon tires for suspension and required the operator to shift gears while driving. SARGE's platform has a suspension system and a continuously variable transmission (CVT), which doesn't require shifting, making SARGE more stable at high speeds and easier to operate.

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Questions or further information: Media Relations Department
last modified: February 2, 1996

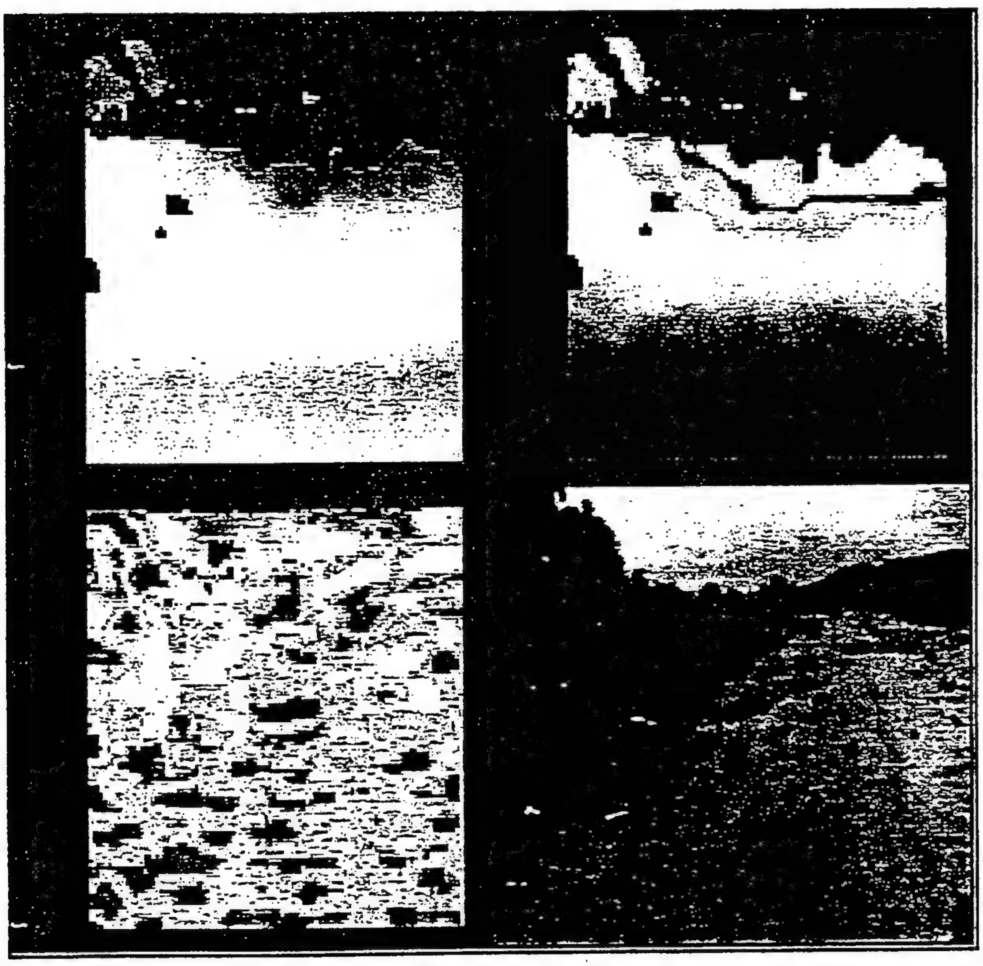
Wide Field-of-View Stereo

Introduction

WFOV, the Wide Field-of-View stereo system, is a JPL-based task in DOD'sUnmanned Ground Vehicles Project, UGV. It is a real-time system which produces dense range maps from a stereo pair of cameras mounted on a HMMWV ("Hum-Vee"), the military's modern-day Jeep equivalent. The range data is being used by higher-level vehicle-control systems for autonomously navigating around local obstacles encountered during battlefield maneuvers.

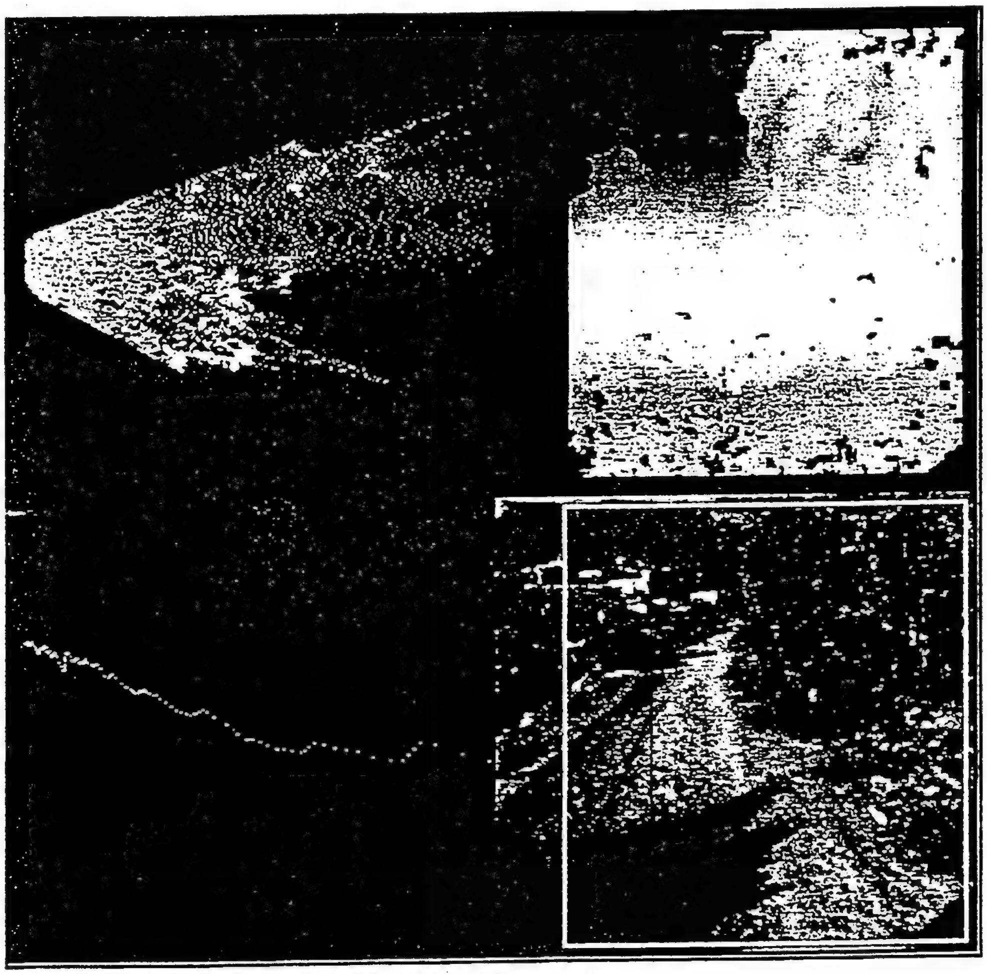
Example 1

Below is a sample image from an early version of the system. In the lower-right corner is the left image from a stereo pair taken in the Arroyo next to JPL. The upper-right shows range data as distance from the cameras. The upper left contains the subpixel disparity image, produced by the stereo system, from which the range data was computed. The lower-left shows confidence data. In all cases the colors span the rainbow, with red being low values and violet being high values.



Example 2

Below is a more recent image showing data at a higher resolution. In the lower-right corner is the left image from a stereo pair taken in another part of the Arroyo next to JPL. The blue overlays indicate locations where positive obstacles were found. The red overlays indicate the leading edges of negative obstacles. The upper-right shows stereo disparity (which is related to distance from the cameras). The upper left contains an elevation map of the range data, with the position of the camera off the left edge of the image. The lower-left shows a side plot of a single column of range data (indicated by the vertical blue stripe in the intensity image). In all cases the colors span the rainbow, with red being low values and violet being high values.

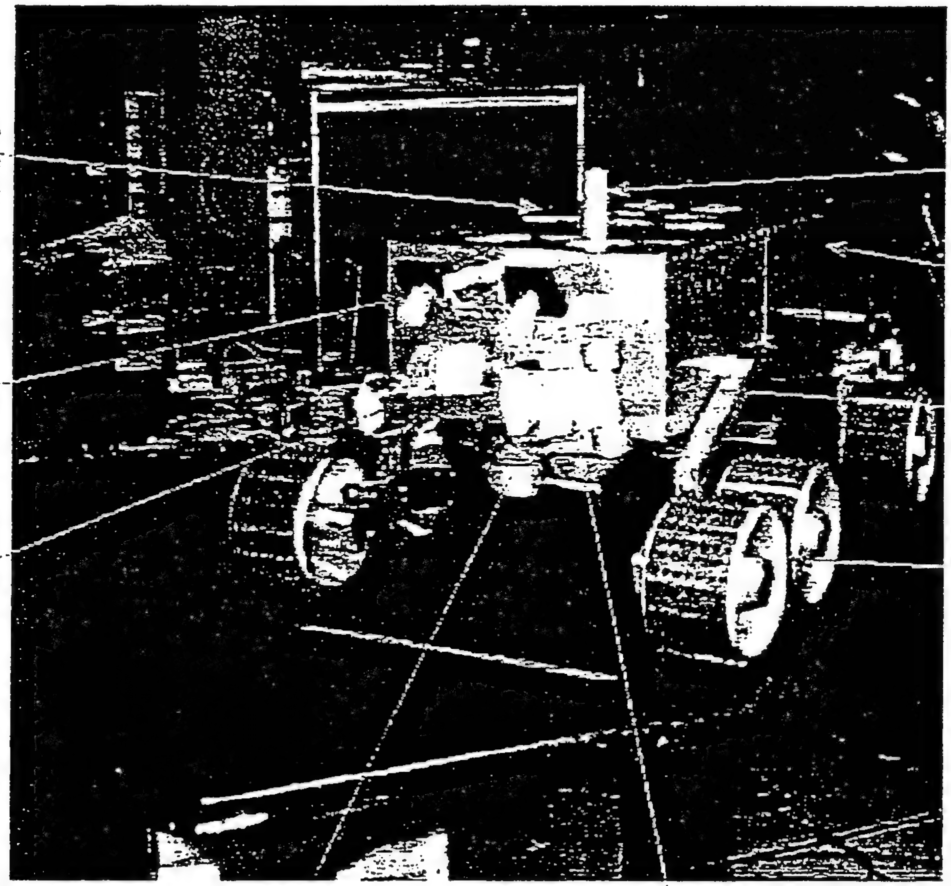


Credits

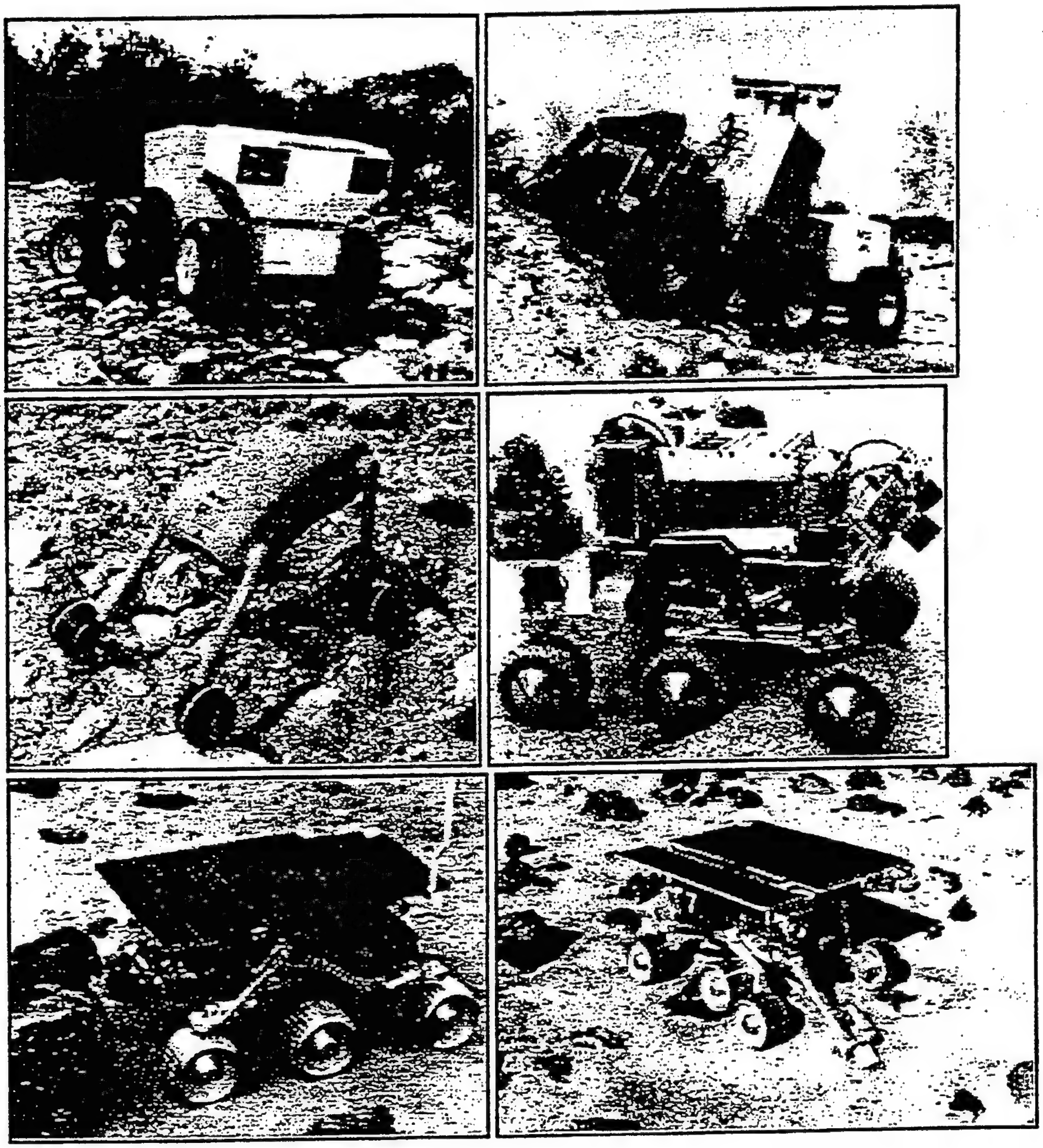
The stereo algorithms were designed and implemented on an earlier prototype system by Larry Matthies, Larry.H.Matthies@jpl.nasa.gov, of JPL. The WFOV system (and this HTML document) was designed and implemented by Todd Litwin, Todd.E.Litwin@jpl.nasa.gov, also of JPL. Additional software support by Greg Tharp. Larry Matthies is the task manager at JPL for the WFOV task. The system is being integrated into the UGV vehicles at Lockheed-Martin Corporation.

Rocky 7

Next Generation Research Micror



Robotic Vehicles Group



Left to right from top-left: (1) The "blue" rover, a three segment early prototype; (2) Robby, with stereo vision and a puma manipulator; (3) Gofor, with active center of gravity compensation; (4) Rocky 3, with laser light stripe obstacle detection and behavior control; (5) Sojourner, the Pathfinder flight rover, based on Rocky 4 and very similar to Rocky 3 in perception and control; (6) Rocky 7, a next generation prototype with stereo vision and sampling manipulator.

The Robotic Vehicles Group performs research, development, and tests of mobile robots in support of planetary exploration missions and terrestrial applications for NASA and other Government agencies. Current operational vehicles range from microrovers weighing under 5 kilograms that are designed for planetary exploration, to 3,000 kilogram military trucks, to rover testbeds with demonstrated cross-country autonomous navigation capability. Other vehicles include teleoperated robots for investigation of hazardous materials spills. Current activities include the development of an autonomous,

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behavior-controlled microrover for science and sample acquisition on the Moon and Mars. The group carries out research in:

- Machine vision
- Terrain geometry estimation
- Local and global vehicle position estimation
- Vehicle control and stability estimation
- Surface properties estimation

An emerging research area involves coordinating mobility and manipulation, then combining them with active force control to accommodate imprecise knowledge either of the terrain or of the motion of the base on which the robotic arm is mounted.

Activities range from basic research in stereo vision to extensive vehicle integration programs that include sensors, actuators, power, and communication systems. Powerful control stations that include stereographic displays for the operator have been developed for effective vehicle commanding. Detailed evaluation and testing of vehicle performance in relevant terrains are major elements of each program.

Members:

- Brian Wilcox, *Supervisor*
- Evelyn Reed, *Secretary*
- Alberto Behar
- Brian Cooper
- Raymond Cozy
- Todd Litwin
- Thomas McCarthy
- Andy Mishkin, *Group Leader*
- Jack Morrison
- Tam Nguyen
- Allen Sirota
- Henry Stone
- Edward Tunstel
- Rick Welch
- Takashi Kubota

Task Involvement:

-  MFEX: Microrover Flight Experiment
-  Long Range Science Rover

Electromagnetic Pulse (EMP)[1]

[1] Steve Douglas and others, Appendix A (Section A-4)

Electrical and Electronics Engineers, Inc. (IEEE), and represents the considered judgment of a group of U.S. IEEE members with expertise in the subject field. The IEEE United States Activities Board promotes the career and technology policy interests of the 250,000 electrical, electronics, and computer engineers who are U.S. members of the IEEE.

BACKGROUND

I. THE NATURE OF EMP SIMULATOR FIELDS

Both outdoor and indoor electromagnetic pulse (EMP) simulators have been in operation at a number of sites. These simulators generate very brief, single pulses of intense, electromagnetic (EM) fields. This energy replicates the non X-ray portion of the energy (i.e., the non-ionizing radiation) that would be produced if a nuclear weapon were detonated in the upper atmosphere. The non-ionizing EM energy that is produced by an EMP simulator is similar in content to the burst of EM energy produced by lightning discharges in the atmosphere, but significantly briefer. The EM fields generated by EMP can disrupt or damage sensitive circuitry in such electronic systems as computers, communications systems, weapons-guidance systems, and telephone lines. To study the vulnerability of electronic systems and components to the destructive effects of a true EMP pulse, non-nuclear EMP simulators have been developed to test protective measures for electronic systems that might be susceptible to EMP-induced damage.

Significant public misunderstanding exists about the nature of the emissions from EMP simulators. In several crucial respects the fields produced by a non-nuclear EMP simulator are very different from the energy produced by the detonation of a nuclear weapon. Non-nuclear EMP simulators produce no ionizing radiation. Such radiation is produced in large quantities by nuclear detonations and is very hazardous. Also, the spatial distribution of non-ionizing radiation from EMP simulators is quite different from the radiation produced by nuclear explosions. Significant EM fields from EMP simulators are limited to short distances from the simulator (a few miles), but nuclear EMP from weapons exploded at high altitudes might exist for many hundreds of miles.

EMP simulators generate single bursts of non-ionizing EM energy. The instantaneous (temporal peak) intensity of this burst is typically less than 100 kiloVolts per meter, which lasts for approximately one microsecond. The intensity of the EM fields decreases rapidly as the distance from the simulator increases. Measured field strengths outside the boundaries of a typical simulator site are lower than the maximum permissible values for human exposure to RF and microwave energy (as specified by U.S. and international safety standards).

II. PUBLIC CONCERNS ABOUT THE POSSIBLE ADVERSE EFFECTS OF EMP FIELDS ON HUMANS BEINGS AND THE ENVIRONMENT

Over the past 20 years, several groups have expressed concerns about the possible adverse effects of EMP fields on humans beings and the environment. These concerned groups have included EMP workers, citizens of communities near operational or proposed EMP simulator installations, public interest groups, and legislators in

the Federal and state governments. Environmental impact and personal injury lawsuits have been filed against operators of several outdoor simulators. One large U.S. Army simulator installation in Woodbridge, Va., has permanently halted all outdoor EMP simulator operations as a result of several years of litigation that was initiated by a private environmental law group. During the latter stages of this litigation, operation of EMP simulators was severely restricted or prohibited. In another instance state governments in Maryland and Virginia prohibited a new EMP simulator (EMPRESS II, 1988) from being operated in the Chesapeake Bay, after many years of costly environmental impact studies and public hearings on the subject.

III. THE LIMITED BODY OF KNOWLEDGE ON THE BIOLOGICAL EFFECTS OF EMP SIMULATOR FIELDS

A. Animal and Human Health-Effects Studies

A number of studies have been conducted to address the concerns about the health and safety of EMP simulator workers. Experiments on laboratory animals and epidemiologic analyses of the health records of workers at EMP simulator sites have been performed. In a series of experiments (Skidmore, 1973; Mattsson, 1976; Baum, 1978; Cleary, 1980), several species of laboratory animals, including dogs, rabbits, rats, and monkeys were exposed to a very large number of EMP-simulator pulses (70,000 to 5,000,000) over periods ranging from a few hours to many days. The field strengths to which the animals were exposed ranged from 100 to 450 kV/m using parallel-plate line exposure devices. Within statistical limits, these studies revealed no clinically significant adverse effects in the various physiological and behavioral endpoints that were monitored. However, none of these studies included measurements that could indicate the magnitude of the electric fields or current densities induced in the tissues and organs of the subjects.

In-vitro (test tube) experiments, in which EMP-simulator waveforms were applied directly to solutions of blood cells, did reveal statistically significant changes in erythrocyte cell membrane permeability (Cleary, 1980). These experiments involved field strengths in the in-vitro solutions that were approximately 200 KV/m. Compared to the E-field induced in humans who are exposed to EMP simulator fields, the in-vitro E-fields were about 10 times more intense, and durations were approximately 25 times longer. Limited information is available on the health records of EMP-exposed workers. Bruner (1977) reviewed medical records of more than 600 workers who received chronic exposures to EMP simulator fields. This study, which evaluated data from annual physical examinations, detected no abnormal incidence of disease. Recently, several investigators have conducted a number of experimental studies to assess the effects of EMP fields on coastal and marine wildlife (EMPRESS II, 1988). These studies found no indications of effects on the general health or behavior of these species of fish, birds, and other marine wildlife that were examined. These studies were limited to less than ten species of animals. Each study involved only a small number of subjects (typically one to ten) and considered only a few biological and behavioral endpoints. However, a detailed review of EMP-related bioeffects literature was published by Aldrich, et al., in 1988. Many abstracts and an extensive bibliography are presented. This paper concluded that adverse biological effects are not evident in the literature. The study concludes that more data on internal fields and current densities are needed in order to compare existing (non-EMP) radiofrequency bioeffects data to the conditions that occur during

EMP exposures.

B. Studies of the Fields and Currents Induced in Humans and Animals Exposed to EMP Simulator Fields

Several engineering studies have evaluated the amount of energy absorbed by human beings exposed to fields from EMP simulators. Measurements (Gronhaug, 1988) and computations (Lin, 1975; Gronhaug, 1986; Guy, 1989; Chen, 1991) determined the magnitudes of electrical currents induced in the body. These studies indicate that the induced current is in the form of a very brief but intense impulse. The waveform of the current is a highly-damped sinusoid wave with a fundamental frequency component of approximately 30-50 MHz. This impulse has a peak amplitude of approximately 500 Amps (current density = 140,000 A/m2). When an adult standing on the ground is exposed to an EMP pulse with a 5 nsec risetime and a peak external, vertically-polarized E-field of 100 kV/m, the maximum induced electric field strength occurs in the ankles and has a peak value of about 150 kV/m. These studies indicate that in spite of the very high peak internal E- field and current densities, the energy absorbed by any part of the body is extremely small (less than 0.2 J/kg). Each pulse can induce a temperature rise of no more than about 50 microdegrees Celsius at any region within the body.

Data on the induced fields and currents in animals exposed to EMP-simulator fields are very limited. One recent study measured the total current induced in the body of laboratory rats in a parallel plate transmission line (Mathur, et al., 1990). The exposure conditions were similar to those used in prior studies of EMP bioeffects on rats. The animal body was perpendicular to the electric field vector. The total current flowing through the animals' bodies to the ground plate on which they were standing was approximately 1.5 Amps peak when using an exposure field of 70 kV/m. Values of maximum spatially-localized current densities and the corresponding specific absorption values were not determined.

Recent computations have estimated the localized current densities and specific absorption induced in computer models of adults, children, and infants, as well as small monkeys, standing upright on the ground while exposed to a 100 kV/m vertically polarized EMP simulator field (Guy, 1990). These values are virtually independent of the height of the subject, as long as the ratio of the height of the body to the diameter of the body, legs, and ankles remains constant.

C. Limitations of Past Studies of the Effects Of EMP Simulator Fields On Animals

The data cited above on induced currents, current densities, and internal E-fields in humans and in animals exposed to the same external "EMP simulator" waveform and field strength raise significant questions of the relevance of the findings of many of the prior studies of bioeffects on animals. These findings cannot be used directly to predict human health effects of EMP simulators. The discrepancy between induced currents in animals versus humans beings becomes smaller for studies involving larger animals, such as dogs (Baum, 1978). Other inadequacies in past studies include the limited types of biological effects studied, particularly for long-term exposures. Thus, any new studies of EMP fields that are performed on laboratory animals should use better exposure techniques and well-quantified induced current densities. If the current densities and induced E-fields are comparable to those

induced in human beings exposed to EMP fields, an improved basis for extrapolating the findings to hypothetical EMP exposures of human beings will result.

D. Relationship Between EMP Exposure and Exposure To Other Kinds of Intense, Pulsed Non-Ionizing Radiation

The most thorough studies of the biological effects of intense, pulsed EM fields have been performed using high, peak-power pulsed microwaves, or "high power microwaves" (HPM). The fields from HPM sources are similar to EMP simulator fields in many ways. Therefore, the findings of studies of HPM bioeffects can provide valuable information to those interested in the bioeffects of EMP. HPM bioeffects studies have featured precise measurements of the induced peak electric fields and the rate of energy absorption in localized regions of animal subjects. Information is available on the mechanisms of interaction of HPM transient exposures, and the threshold-induced field and energy levels that induced effects. Several researchers have exposed laboratory animals to pulsed microwave fields whose pulse widths and peak external electric field strengths were similar to those of EMP simulator fields (Creighton, 1987; D'Andrea 1988; Klauenberg, 1988; Wachtel, 1989; Lin, 1989). These studies involved exposures of up to several hundred pulses per day. In general, the results indicate that only one parameter appears to produce acute effects: the instantaneous local temperature rise. "Biologically ineffective" exposures were those that induced less than 0.1 degree Celsius local temperature rise. Thus, high instantaneous peak electric field strengths and high rates of energy absorption have not been shown to cause biological effects, if the exposures induce low levels of energy in localized regions or the entire body.

The results cited above can be loosely extrapolated to the case of intense, very brief pulses from sources such as outdoor EMP simulators. The threshold for biological effects was related directly to the local energy density induced in animals exposed to single pulses or to bursts of multiple pulses. The instantaneous peak intensity of the electric field was not found to be a significant factor in producing effects with exposures that induced transient temperature elevations below 0.1 degrees Celsius in any region of the subject's body. The threshold of effects for brief bursts of pulsed microwaves is approximately one thousand times higher than the energy density induced in any region of the human body when human beings are exposed to typical EMP simulator fields.

IV. RELEVANT SAFETY STANDARDS

Many safety standards have been promulgated by various national and international organizations to regulate exposures of personnel to EM fields in the radiofrequency range (ANSI, 1982; ACGIH, 1990; IRPA, 1988). All of these standards deal directly with continuous wave (CW) and conventional amplitude-modulated non-ionizing radiofrequency electromagnetic fields and with the time-averaged value of amplitude modulated and pulsed RF. Most of the safety standards address only hazards of intense, transient electromagnetic fields by imposing limits on the time-averaged energy delivered or absorbed by the human body. The intensity and brevity of EMP fields, as well as their instantaneous rate of energy absorption differ significantly from the sources of RF fields that are addressed by these safety standards.

Therefore, new safety standards that address the temporal peak of

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intense, brief pulsed EM fields are needed. These standards must address the high induced electric field strengths and current densities in various parts of the human body. Several of the latest revisions of existing RF safety standards address this issue directly (ACGIH, 1984), (DODI, 1986), (IEEE SCC28, 1991).

The safety standards cited above, which address transient RF fields, limit human exposures to pulses with a peak electric field strength of 100 kV/m. These limitations generally are based on the premise of limiting the total energy absorbed by a human being over a period of several minutes. Also, recent standards address the issue of protecting personnel from the possibility of electrical shock and RF burns when touching large metal objects during exposure to very intense RF transient fields. EMP simulator pulses fall well within these limits. Based on present knowledge, the above standards appear to offer protection from any known hazard of intense pulsed EM fields, including those generated by EMP simulators. Additional considerations for effects of long-term exposures are needed in future revisions of these standards. This requires an improved biological effects data base and accompanying dosimetry to address these issues adequately.

V. CONCLUSIONS AND RECOMMENDATIONS

There is significant public concern about the potential hazards to persons exposed to the fields produced by EMP simulators, as well as the impact of these fields on the environment. At the present time, there is no notable evidence of potential harm to persons exposed to these fields. This is due to the lack of bioeffects found in experimental studies of animals exposed to intense but very brief (sub-microsecond) EMP and microwave fields. In addition, no known biophysical mechanisms of interaction exist for these types of induced fields and current impulses. Therefore, given current knowledge, IEEE-USA believes that there is no threat to persons or the environment from repeated exposures to fields from EMP simulators. There are several existing and newly proposed safety standards for exposure of human beings to intense pulsed radiofrequency EM fields. Conforming with these exposure guidelines should provide a significant margin of safety for persons working or living near EMP simulator sites.

Despite the data cited above, there are gaps in our knowledge of the effects of chronic exposures to EMP fields. Several methodological flaws exist in virtually all studies of the biological effects of EMP exposures of laboratory animals. This creates a situation which leaves unanswered certain public concerns about EMP simulators. Therefore, we believe that additional research on the biological effects of EMP exposures should be performed using laboratory animals. These studies should feature exposure methods that induce peak, transient electric fields in the animals' bodies that are equal to those induced in human beings who are exposed to EMP simulator emissions. These new studies should be performed by interdisciplinary teams of biomedical scientists and engineers familiar with the principles of electromagnetic field coupling to biological subjects and with the latest information on the mechanisms of interactions of EM fields with biological systems.

REFERENCES

ACGIH (American Conference of Governmental and Industrial Hygienists). "Threshold Limit Values for Radiofrequency/Microwave

www.infowar.com/mil_c4i/c4i8.html-ssi #1

ALCMS GIVEN NONLETHAL ROLE

DAVID A. FULGHUM/WASHINGTON

U. S. retrofitting older cruise missiles to carry disabling warheads that could be used to settle regional conflicts with a minimum of civilian casualties

The Defense Department is retrofitting hundreds of its older, long-range air launched cruise missiles to improve their stealth characteristics and adapt them to carry conventional and new families of nonlethal but disabling warheads that could be useful in conflicts like that in the Balkans.

The Air Force AGM-86 air-launched cruise missile in particular is being modified as they are pulled out of the nuclear attack role. Most notably, some of the 1,500-mi.-range missiles will be fitted with a nonnuclear, electro-magnetic pulse (EMP) generator.

An EMP missile, flying at low altitude into an area with key enemy command and control sites, can explode, thus producing a momentary burst of microwaves powerful enough to disable all but special, radiation-hardened electronic devices.

The headquarters of a large army unit or a naval task force exposed to attack by a number of EMP weapons would be left "blind, deaf and dumb," a Washington-based defense analyst said. "They are not that expensive" and they would create "widespread havoc with electronics in short order."

Air Force officials confirmed that ALCMs are being shifted to new conventional attack and decoy roles, but refused comment on EMP-warhead development. The capability would be invaluable, "but I'd keep it in my hip pocket [secret] until I needed to use it," a senior official said.

A nonnuclear EMP burst is produced by creating a magnetic field in a coil and then squeezing it by the detonation of conventional explosives. The resulting pulse of microwave energy can carry thousands of feet and damage or upset electronic components. In early 1993, private automobiles parked about 300 meters from a U. S. EMP generator test site had their coils, alternators, electric seats and electronic engine controls accidentally disabled by the pulse.

During the Cold War, researchers in

CLINTON ORDERS NEW DESIGN FOR SPACE STATION

WASHINGTON

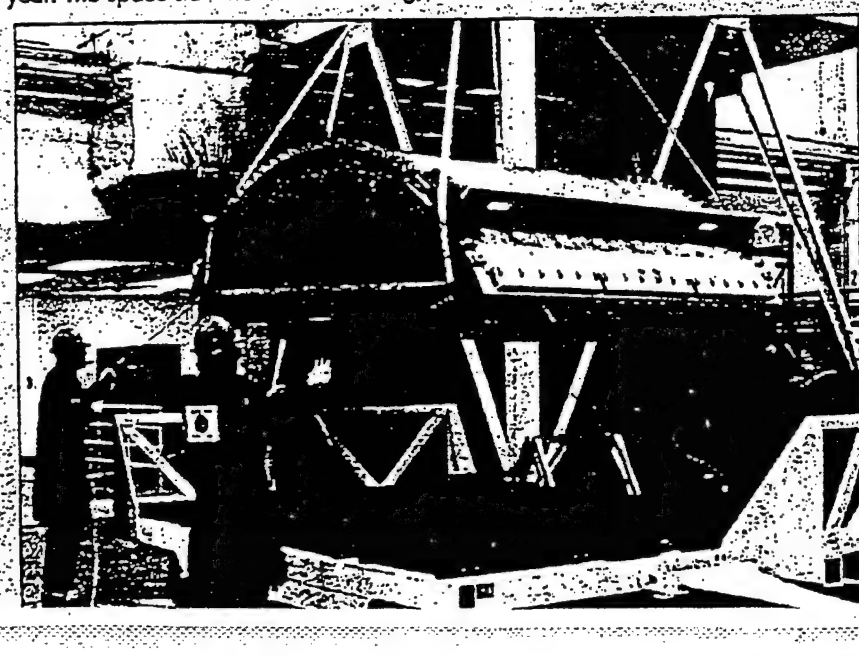
The Clinton Administration has ordered NASA to redesign the space station once again to reduce costs. The savings would be put into other space programs and aeronautics research.

The president will propose a $14.7-billion budget for NASA for Fiscal 1994, up from $14.1 billion this year. The space station would receive $2.305 billion. If approved by Congress, that will boost station spending from this year's $2.1 billion, but still fall short of the $2.5 billion the space agency had planned.

NASA Administrator Daniel S. Goldin told *AVIATION WEEK & SPACE TECHNOLOGY* he is delighted that the new administration wants to rein in station costs and boost aeronautics spending.

"I was frustrated that the program was out of balance," he said. "It would be unconscionable if we proceeded with a fully funded space station—given the tremendous budget deficit problem this country has—at the expense of not starting any new activities in [lightweight, lower-cost] spacecraft. It would be a crime for NASA not to step up to a vigorous aeronautics program."

"We don't know what it's going to look like," Goldin said of the new station design that will emerge. But he said, at least for the time being, no station contracts will be canceled.



Boeing's first item of qualification hardware, an aluminum section of a space station node, is moved after baking in an autoclave in Huntsville, Ala.

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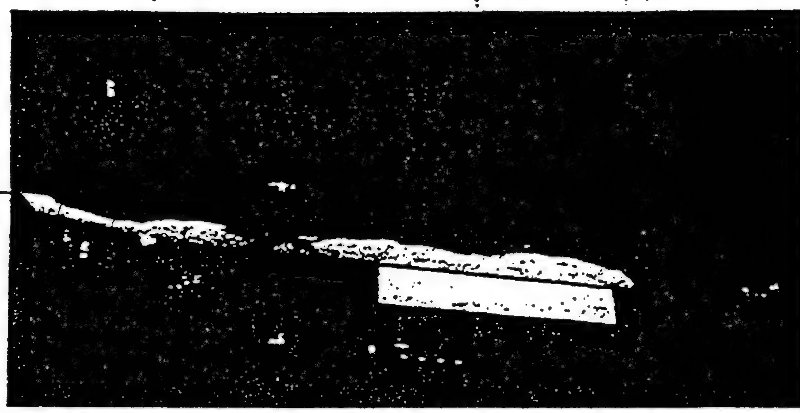
Hundreds of the Defense Dept.'s older air launched cruise missiles are being made more stealthy and reequipped with non-lethal warheads.



the former Soviet Union developed an EMP weapon, a magneto-cumulative generator at the Arzamas 16 nuclear weapons laboratory near Nizhny Novgorod.

In the wake of the Persian Gulf war, U. S. defense officials confirmed to *AVIATION WEEK & SPACE TECHNOLOGY* that the U. S. was researching its own EMP weapons at Los Alamos National Laboratory, N. M., and Eglin AFB, Fla., as part of a nonlethal, disabling weapons program.

The U. S. Army's Training and Doctrine Command developed a still unreleased operational study for such weapons last year. It specifically mentioned the use of high-powered generators to "degrade enemy [intelligence] collection, processing and communications systems." Such an attack would "allow the Army to hide friendly forces' intentions and disposition," the report said.

On a localized basis, EMP generators also could damage solid-state ignitions on vehicles, detonators, communications, radar and aircraft electronics. On a wider stage, the disabling of key computers could stop a belligerent state's production and distribution of electricity, natural gas, petroleum, oil and lubricants without destroying production facilities.

However, the physical dimensions of the EMP generator, and possibly other nonlethal weapons, has forced the Defense Dept. to redesign some ALCMs into shapes that have been described as "non-traditional, strange, non-aerodynamic," by an observer. A "bulbous, pointed ogive [nose cone]" shape is broken by a flat, down and forward-angled surface near its nose.

The flat panel is optically transparent

The president settled on the new plan for NASA after two weeks of infighting at the White House—a high-level debate from which even Goldin was often excluded. At various points, it seemed Clinton might move to cancel the station altogether, fully fund it or cut the program back substantially.

CLINTON'S BROAD AIM seemed clear: to bring total station costs down without inflicting even more layoffs in the beleaguered aerospace industry. But many of the details remained uncertain late last week, as top station officials both in the U. S. and abroad complained that the White House had left them in the dark or carelessly tossed about terms and figures.

On Capitol Hill, White House officials said the station would be budgeted at about $1.8 billion a year in 1995-98, according to sources familiar with the closed briefings, which took place before the president released the details of his economic plan. However, Goldin said he had not been given "outyear" budget targets for the station but was merely told to reduce the station's life-cycle costs.

Goldin said Clinton had directed him "to redesign the space station as part of a program that is more efficient and effective and capable of producing good returns on our investment... a streamlined, cost-effective design, assuring stability during the transition and minimizing any potential job losses."

The order also appears to assure that Goldin will remain at NASA's helm for some months, though he said he knew nothing of a reported 60-90-day deadline for the redesign.

Goldin told NASA and contractor employees Feb. 18, the redesign "is not a problem. This is a challenge."

But with some $8 billion spent on developing the orbital base over nearly a decade that has included half a dozen redesigns or program overhauls, many involved in the program are skeptical. Station contractors, led by Boeing, McDonnell Douglas, Rocketdyne and Grumman, have begun drawing detailed blueprints and making test articles and even some flight hardware. So slips are seen as inevitable in the current schedule to launch the first elements in mid-1996 and complete the station in mid-2000.

NASA's international partners are concerned about the impact on them. Ian Pryke, the head of the European Space Agency's office here, said ESA would "make it very clear that we expect to be involved" not only in the redesign but in setting the ground rules for the redesign. Representatives of Japan and Canada expressed similar concerns.

According to the president's report, A Vision of Change For America, Clinton's budget for NASA will increase to $15.5 billion in 1995 and keep growing slightly each year through 1998, when it will reach $16.6 billion.

IT ALSO SAID Clinton would ask to spend some $2.636 billion over the years 1994-98 on NASA to "redesign space station and invest in new technology."

In a table of "investment proposals," including a section on "technology and business reinvestment and defense conversion," the report said the Administration would add new spending of $817 million over the same period on NASA civil aviation and an additional $70 million on NASA short-haul aircraft research.

Part of what led the new administration to order NASA to restructure the station program was the prospect that the agency would not be able to keep the effort on schedule and under budget. The biggest threat of a cost overrun looms in so-called Work Package 2, in which NASA's Johnson Space Center oversees prime contractor McDonnell Douglas (*AW&ST* Feb. 8, p. 20).

Criticism of the work package reached a new plane, even for the controversial station program, when a U. S. senator, Sen. Bob Krueger (D-Tex.), called for—and got—the removal of NASA's station manager in Houston, John Aaron. ■

E-2-7

EMP WEAPONS LEAD RACE FOR NON-LETHAL TECHNOLOGY

DAVID A. FULGHUM/WASHINGTON

The electromagnetic pulse generator is emerging as one of the strongest contenders from among dozens of technologies in the U. S. military's race to find effective weapons to defeat an enemy without causing loss of life.

It is known that "as you vary the electromagnetic field, you can produce upset of electronic devices by scrambling digital memories or causing the device to destroy itself by diverting current to sensitive components," according to a senior scientist at Los Alamos National Laboratory.

THEREFORE, the services are pressing ahead in research on small devices that can generate "ultra wide-band, high-power microwaves" that can be used to "disable any vehicle [trucks, missiles and aircraft] dependent on electronic circuits to operate," according to an unreleased document produced by the Army's Training and Doctrine Command. This research thrust has been confirmed by defense, research and industry officials.

Initial tests of the U. S.'s first nonnuclear, electromagnetic pulse (EMP) weapon earlier this year were flawed but promising, according to Pentagon and industry officials.

The device, which uses conventional explosives to generate a highly directional EMP strong enough to disable or damage electrical equipment, "didn't quite do everything we expected [it] to," a senior Pentagon official said.

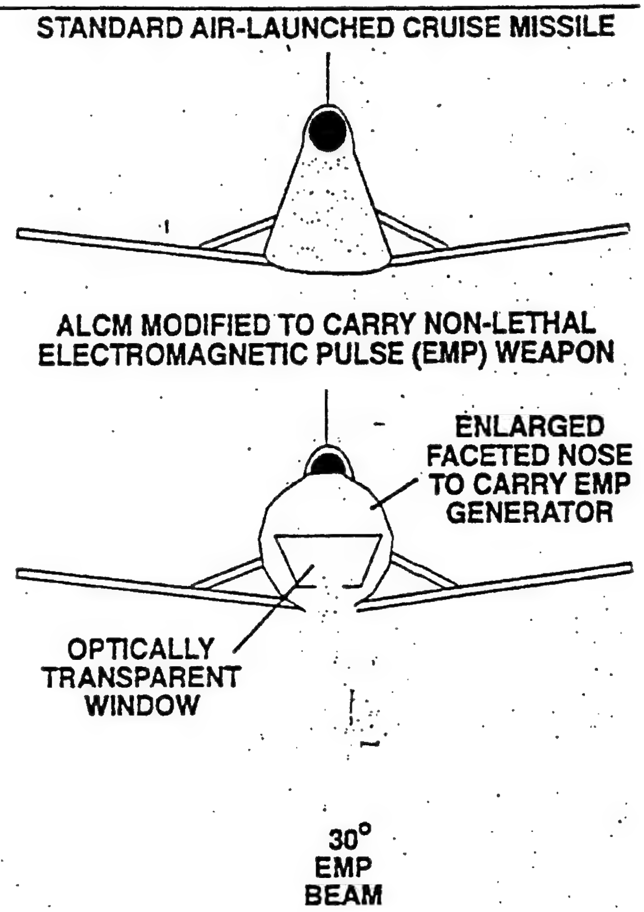
But an aerospace industry insider said the results were effective enough to unintentionally damage the ignitions and engine controls of privately owned automobiles about 300 meters from the test site. The cars were not part of the experiment, but the effects upon them were exactly what experimenters are looking for.

The EMP generator is being developed by the Air Force and sized to fit into air-launched cruise missiles (ALCMs) that have been modified with bulbous new noses. The altered noses are constructed of many small, flat panels, somewhat like a miniature version of the F-117's skin. A trapezoidal, optically transparent panel in the nose is used both as an opening for target sensors and as an exit route for the narrow EMP beam.

Secrecy-shrouded testing of an EMP-generator weapon has been conducted within the last four years at Los Alamos National Laboratory and is currently ongoing at Eglin AFB, defense and industry officials confirmed.

While Los Alamos officials will not discuss military applications of EMP generators, a similar technology is being employed there for peaceful research in plasma physics, high-pressure chemistry and fusion power.

Scientists have developed a high explosive-driven pulsed power generator consisting of a helical coil wrapped around a copper cylinder filled with high explosives. A bank of capacitors supplies an initial current of a few hundred thousand amps that creates a magnetic field in the gap between the coil and cylinder. The explosion compresses the magnetic field and creates a very short-duration pulse of high power, according to the senior Los Alamos scientist.



The militarized Air Force EMP generator is said to differ from the Los Alamos device in that the explosives surround the electronic coil, an aerospace industry official said. In the Air Force's effort, compression of the explosion then helps produce a highly directional EMP pulse.

DURING A RECENT TEST, Los Alamos' 2-ft.-wide by 10-ft.-long Procyon-design generator produced a 12-16-million-amp pulse with a rise time of only 400 nanoseconds, a Los Alamos official told *AVIATION WEEK & SPACE TECHNOLOGY.* The effective power of over four trillion watts "exceeded the electrical generating capacity of the rest of the planet," he said.

The Russians, who pioneered nonnuclear EMP weapons work during the Cold War, have reported extensive work with explosive-driven generators for peaceful purposes with capabilities substantially ahead of U. S. designs, a pulse power specialist said. Experiments using large disk-shape designs have produced pulses of over 200 million amps. Smaller 16-in.-wide by 40-in.-long versions of the Russian-designed generators produced about 30 million amps, he said. The U. S. Air Force has had to work with similar small-sized generators to fit into modified Air Launched Cruise Missiles, and the 30-million-amp output is not greatly different from the power generated by the Air Force's EMP weapon, an aerospace industry official said.

But "it's not so much the power as the ability to focus the output" that concerns the military, he said. "The key is depositing energy at the right range on a target."

The Air Force's EMP weapon uses a "well-tuned, average-tech antenna" that operates much like the reflector dish behind a flashlight bulb, the aerospace official said.

The antenna focuses the generator's output within "about a 30-deg." swath to concentrate on a specific target within several hundred meters of the missile. ■

Unmanned Air Vehicles (UAV's)[1]

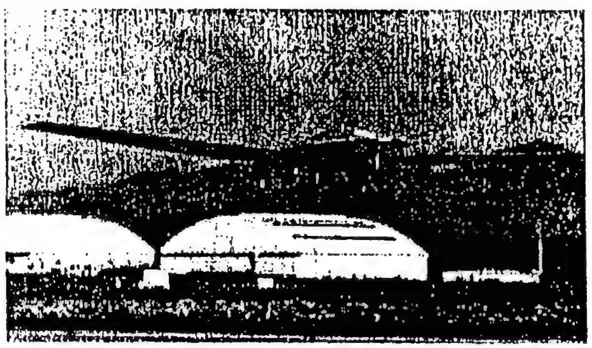
[1] Steve Douglas and others, Appendix A (Section A-5)

Unmanned Air Vehicles

UAVs hold great potential for civil, commercial, and military use. Without having to engineer aircraft around the human body, UAVs allow for revolutionary changes in the way we design aircraft. In the next forty years we can expect to see UAVs moving into every field of aviation. Below are listed a few of the most recognized UAVs in the civil and military fields.

E-3-1

Dark Star

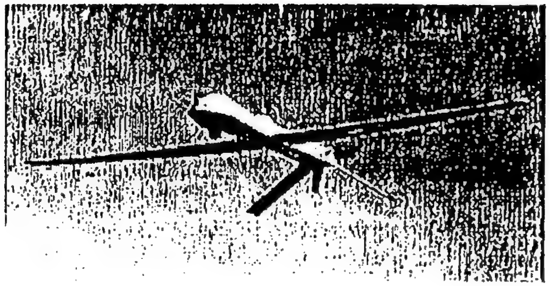


Above View

Mission (ft.)	Acq./ recon./surv.	Length (ft.)	15
Powerplant	1 x William Rolls Fj44 tf	Wingspan (ft.)	65
Playload Type	SAR	Body Dia. (ft.)	12
Speed (mph.)	288+	Weight (lb.)	8600
Endurance (hrs. or mi.)	8 hr.+	Max. Altitude (ft.)	45,000

Lockheed Martin Skunk Works project developed with Boeing. The elaborate Tier 3- Dark Star suffered a setback in 1996 with the crash of its first prototype. Such a UAV is intended to bridge the gap between the small tactical UAVs and reconnaissance satellites. Design utilizes many stealth features

Predator



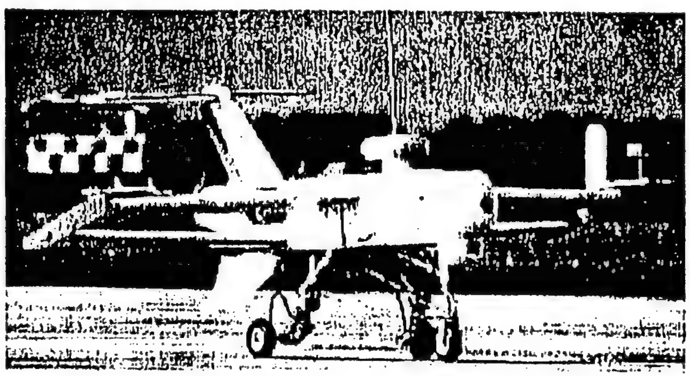
Ground Station

Mission (ft.)	Recon./surv./target	Length (ft.)	28
Powerplant	1x Rotax 912 gasoline	Wingspan (ft.)	48
Playload Type	Day TV, FLIR, SAR	Body Dia. (ft.)	2.5
Speed (mph.)	65-80	Weight (lb.)	2300
Endurance (hrs. or mi.)	23 hr.	Max. Altitude (ft.)	25,000

E-3-2

General Atomics UAV in service around the world. The success of the Predator in Bosnia has attracted favorable U.S. Congressional attention, leading to additional funding for U.S. UAV programs. In early 1996, a Predator GPS flight control system returned it to its base in Hungary- even after the command link was lost over Bosnia.

Outrider



Cut-away view

Mission (ft.)	Multipurpose	Length (ft.)	9.9
Powerplant	Heavy fuel engine	Wingspan (ft.)	11.2
Playload Type	EO/IR	Body Dia. (ft.)	1
Speed (mph.)	126	Weight (lb.)	385
Endurance (hrs. or mi.)	4.9 hr.	Max. Altitude (ft.)	15,000

Tactical UAV slected by the Army, Marines, and Navy. Deployable from land or shipdeck. Auto takeoff and landing.

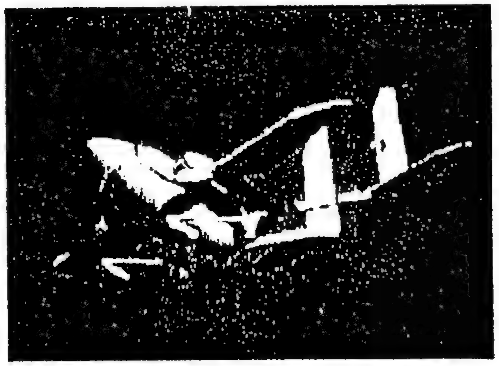
E-3-3

Global Hawk

Mission (ft.)	Recon.	Length (ft.)	44.4
Powerplant	1x Allison AE3007H tf.	Wingspan (ft.)	116
Playload Type	- by Hughes	Body Dia. (ft.)	4.8
Speed (mph.)	395	Weight (lb.)	24,000
Endurance (hrs. or mi.)	42 hr./ 16,566 mi.	Max. Altitude (ft.)	67,000

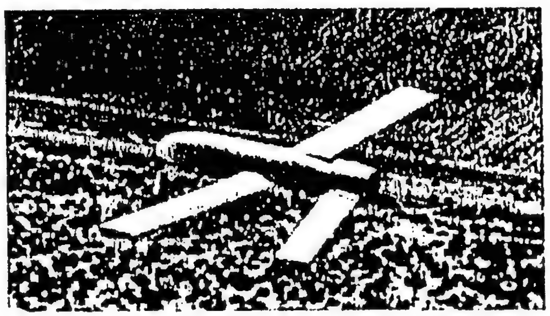
Still in development. This UAV is meant to fly a very aggresive flight plan and carry out missions performed before by aircraft such as the SR-71.

Scorpion 100



Mission (ft.)	Multipurpose	Length (ft.)	11.8
Powerplant	1x Rotax 50 hp.	Wingspan (ft.)	16.1
Playload Type	Day.night E/O; 50 lb.	Body Dia. (ft.)	1.7
Speed (mph.)	173	Weight (lb.)	321
Endurance (hrs. or mi.)	3-5 hr.	Max. Altitude (ft.)	15,000

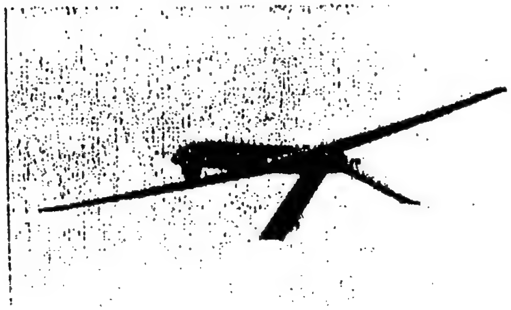
Prowler



Mission (ft.)	Recon./surv./target	Length (ft.)	11.1
Powerplant	1x Norton NR731	Wingspan (ft.)	18.1
Playload Type	Day TV, E/O, IR	Body Dia. (ft.)	1.8
Speed (mph.)	184	Weight (lb.)	200
Endurance (hrs. or mi.)	8 hr.+	Max. Altitude (ft.)	20,000

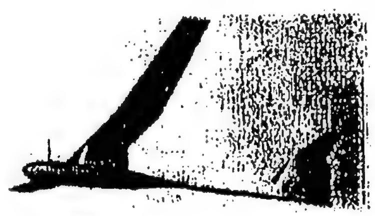
E-3-4

Gnat



Mission (ft.)	Recon./surv./target	Length (ft.)	18.9
Powerplant	1 x Rotax 912 gasoline	Wingspan (ft.)	42
Playload Type	Day TV, Flir	Body Dia. (ft.)	2.5
Speed (mph.)	201	Weight (lb.)	1,400
Endurance (hrs. or mi.)	60 hr.	Max. Altitude (ft.)	32,000
Exported to Turkey.			

Pointer

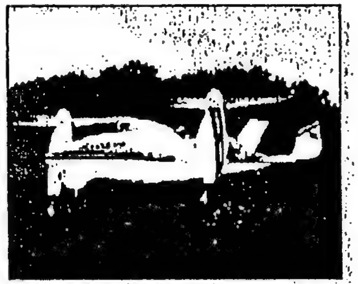


Mission (ft.)	Multipurpose/recon.	Length (ft.)	6
Powerplant	1 x Astro 15 elec.	Wingspan (ft.)	9
Playload Type	Day/IR sensors	Body Dia. (ft.)	-
Speed (mph.)			

PRODUCTS

UAV EAGLE EYE

UAV



12/19/97 Press Release
03/02/98 Press Release

This Eagle Eye® Tiltrotor Unmanned Air Vehicle (UAV) can take off or land anywhere, without the need of a runway. Maximum speed: 200 kts, 370 kph. Range (sea level): Radius of Action after one hour on station - 500 nm, 925 km.

E-3-6

BOEING

electronics/
information systems

DarkStar UAV

The DarkStar unmanned aerial vehicle, a prototype developed by the team of Boeing and Lockheed Martin Skunk Works, successfully completed its first flight on Friday, March 29, 1996. The 20-minute flight took off from Edwards Air Force Base, Calif., at 6:25 a.m. (PST). DarkStar reached an altitude of 5,000 feet and completed basic flight maneuvers.

Boeing and Lockheed Martin are developing the low-observable, high-altitude UAV -- with a fuselage length of 15 feet and a wingspan of 69 feet -- for the Department of Defense. Powered by a single turbofan engine, it can operate at ranges greater than 500 nautical miles and loiter for more than eight hours at altitudes greater than 45,000 feet. DarkStar's mission will be to penetrate aggressively defended airspace.

Boeing Home | Military Airplanes

E-3-8

NASA GSFC/Wallops Flight Facility
Unmanned Aerial Vehicles

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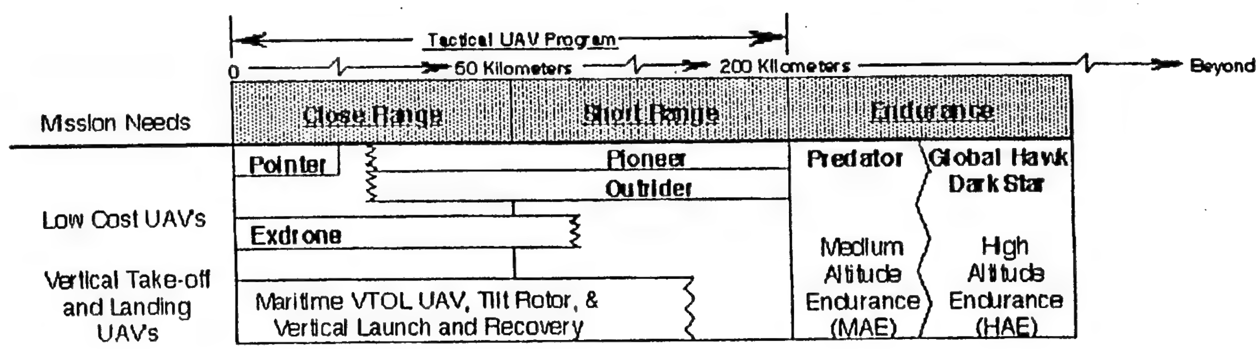
Unmanned Aerial Vehicle Categories



Other U.S. UAV Development/Production Activity

Local	Regional	Endurance	
Shadow 200	Shadow 600	Chiron	Pathfinder
AV Pointer Moro Blimp	Truck	BQM-34	Perseus B
SASS Lite Blimp	Skyeye	Model 324	Raptor
Javelin	Eagle-Eye	Model 350	Theseus
Porter	Aerobot (A24-2)	Model 410	Helios
Tern	Spectre II	GNAT 750	
H-7B	Seabat	Altus 2	
H-7F	S-TEC Sentry		
H-7H	Hunter		
Freewing Tilt-Body			
Huntair			
Prowler			
Flash			
HIT			
Aerobot (FS-24)			
Aerosonde			
Cypher			
XAP			

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UAV Characteristics Database

Click on the name of a UAV to display the characteristics for that vehicle.

Unmanned Aerial Vehicle Name	Endurance (Hours)	Payload Weight (Pounds)	Altitude Capability (Feet)	Costing Info
AV Pointer	1 hr.	2 lbs.	3,000 ft.	Yes
AV Pointer Micro Blimp	2 hrs.	1.5 lbs.	3,000 ft.	Yes
Aerobot	n/a	n/a	n/a	-
Aerosonde	24 hrs.	2.2 lbs.	13,000 ft.	Yes
Altus 2	24 hrs.	450 lbs.	26,000 ft.	Yes
BQM-34	1.25 hrs.	470 lbs.	60,000 ft.	Yes
Chiron	8 hrs.	700 lbs.	19,000 ft	-
Cypher	2.5 hrs.	45 lbs.	5,000 ft.	-
Darkstar	8 hrs.	1,000 lbs.	45,000 ft.	Yes
Eagle Eye	8 hrs.	300 lbs.	20,000 ft.	-
Exdrone	2.5 hr.	25 lbs	10,000 ft.	-
Firebee	1.25 hrs.	470 lbs.	60,000 ft.	-
Freewing	3.5 hrs.	50 lbs.	15,000 ft.	-
Global Hawk	42 hrs.	1,960 lbs.	65,000 ft.	Yes
Gnat 750	48 hrs.	140 lbs.	25,000 ft.	Yes
Hawk-i 7B	1 hr.	3 lbs.	3,000 ft.	Yes
Hawk-i 7F	2 hrs.	12 lbs.	3,000 ft.	Yes
Hawk-i 7H	1 hr.	5 lbs.	3,000 ft.	Yes
Huntair	7.5 hrs.	80 lbs.	17,000 ft.	Yes
Hunter	12 hrs.	200 lbs.	15,000 ft.	-
Javelin	1.5 hrs.	6 lbs.	3,000 ft.	-
Model 324	2.5 hrs.	200 lbs.	43,000 ft.	-
Model 350	1 hr.	400 lbs.	40,000 ft.	-
Model 410	12 hrs.	300 lbs.	30,000 ft.	-
Outrider	4 hrs.	160 lbs.	15,000 ft.	Yes
Pathfinder	16 hrs.	88 lbs.	70,000 ft.	-
Perseus B	72 hrs.	441 lbs.	65,620 ft.	-
Pioneer	5.5 hrs.	75 lbs.	12,000 ft.	Yes
Porter	4 hrs.	75 lbs.	5,000 ft.	Yes
Predator	20 hrs.	450 lbs.	26.000 ft.	Yes
Prowler	6 hrs.	50 lbs.	21,000 ft.	-
Raptor	8 hrs.	75 lbs.	65,000 ft.	-
SASS Lite	5 hrs.	100 lbs.	9,850 ft.	-
STM-5B	6 hrs.	75 lbs.	16,000 ft.	-
Seabat	3 hrs.	50 lbs.	10,000 ft.	-

Shadow 200	4 hrs.	50 lbs.	15,000 ft.	-
Shadow 600	14 hrs.	100 lbs.	17,000 ft.	-
Skyeye	10 hrs.	175 lbs.	18,000 ft.	-
Spectre II	6 hrs.	85 lbs.	23,000 ft.	-
Tern	4 hrs.	22 lbs.	3,000 ft.	-
Theseus	50 hrs.	750 lbs.	88,500 ft.	-
Truck	4 hrs.	50 lbs.	5,000 ft.	Yes

Edit the UAV Database (Restricted Access).

Observational Science Branch; Laboratory for Hydrospheric Processes
NASA GSFC/Wallops Flight Facility
NASA Official 972/Laurence C. Rossi, Maintained by CSC/Jeff Lee.

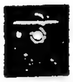
Wide Area Munition (WAM)[1]

[1] Steve Douglas and others, Appendix A (Section A-6)

Weapon Systems

Dominate the Maneuver Battle

Wide Area Munition (WAM)



MISSION: The mission of the Wide Area Munition (WAM) is to counter the enemy's mobility. It will delay, disrupt and canalize enemy vehicle movement in the close battle. Future variants will perform these functions in deep battle.

CHARACTERISTICS: The WAM is the Army's first generation of a smart, autonomous top attack munition. It employs seismic and acoustic sensors to detect, classify and track a target. Once the target is validated by internal control electronics and within the 100 meter lethal radius, the munition determines the optimum firing point and launches a submunition over the target. The sublet acquires the target by infrared sensor and fires a tantalum explosively formed penetrator (EFP) at the top of the target vehicle.

FOREIGN COUNTERPARTS: None known.

PROGRAM STATUS: The WAM is currently in EMD. Milestone IIIa is scheduled for 4QFY95, Milestone III is scheduled for 4QFY96.

PROJECTED ACTIVITIES: Critical Design Review is scheduled for March 1995.

LRIP contract is planned for a 2QFY96 award.

TT/UT will be comleted by 4QFY96.

PRIME CONTRACTOR: Textron Defense Systems (Wilmington, MA)

SUBCONTRACTORS:
Hughes; Fullerton, CA
Opto-Electronics; Petaluma, CA
Mason and Hanger; Burlington, IA
Textron Defense System; Wilmington, MA
Eagle Picher; Joplin, MO
Texas Instruments; Dallas, TX
Hercules; Rocket City, WV

Systems Fielded or in Production

TACOM-ARDEC is a world leader in munitions technologies and providing state-of-the-art systems to its customers - the soldiers in the field. The following descriptions illustrate some of TACOM-ARDEC's most successful systems and detail the weapon systems which TACOM-ARDEC has helped to put into the field.

SADARM (Sense and Destroy Armor) is a 155mm artillery projectile designed to

attack armored vehicles, especially self-propelled howitzers. Rounds containing two SADARM submunitions are launched to within the submunition's attack footprint; separating from the carrier, the submunitions descend on parachutes and detect and identify priority targets using infrared and millimeter-wave sensors and onboard computers. At the appropriate standoff, the submunition detonates, forming an EFP which destroys the target by attacking the relatively weak top armor.

Return to top of list

WAM (Wide Area Munition) consists of three major subsystems:

- a communications module,
- a ground platform module, and
- a smart submunition/warhead (sublet) module.

Once deployed, the WAM uprights itself and autonomously searches for a target vehicle. WAM uses acoustic and seismic sensors to locate, identify and track armored targets. When a firing solution is satisfied, the WAM launches a sublet in a trajectory over the target. The sublet uses a passive infrared sensor to detect the target and fires an Explosively Formed Penetrator (EFP) at the vulnerable area. In addition, the WAM has a command destruct capability for easy battlefield cleanup. WAM is currently planned for hand-emplacement with the potential for a deep attack, indirect fire delivered variant in the future.

Return to top of list

TACOM-ARDEC is a world leader in the design and development of **Mortar Systems.** Under the direction of Project Manager, Mortars, TACOM-ARDEC has fielded many systems including the 60mm Lightweight Company Mortar System, the improved 81mm Mortar System, and a 120mm Battalion Mortar System. Some of TACOM-ARDEC's most notable accomplishments are the 81mm blast attenuation device, which allows the mortar to be fired at longer ranges by reducing blast overpressure near the crew; the 60mm and 81mm

[Top] [Prev] [Next] [Bottom]

The Hornet: A Wide-Area Munition

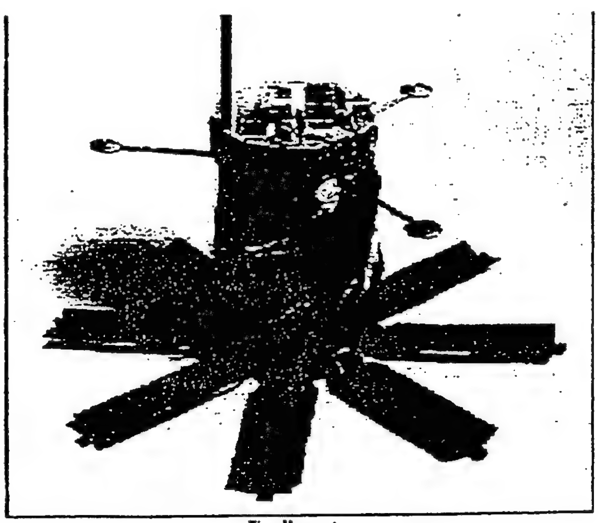
By Major Gregory Fields

The Army recently completed development of the world's first wide-area munition (WAM). The M93 hand-emplaced WAM, popularly known as the Hornet, fulfills the Army's need for a lethal, deployable munition that will defeat armored vehicles at and beyond direct-fire ranges. The Hornet is the first in a family of Hornet derivatives that will change the way engineers fight and how we will influence the battle.

The Hornet program began in 1986 with a Department of the Army message. A required operational capability document was approved in 1990 that outlined a prioritized, three-phased WAM development plan: (1) deep-attack, (2) hand-emplaced, and (3) Volcano-emplaced. With the collapse of the Soviet Union and the rise in importance of early-entry operations, the priority was changed to (1) hand-emplaced, (2) hand-emplaced with two-way communication and redeployability, and (3) deep-attack.

Initially, contracts were awarded to two contractors. Alliant Techsystems' WAM prototype was based on the sense and destroy armor (SADARM) artillery warhead. Textron Defense Systems' prototype was based on their U.S. Air Force extended-range antiarmor munition proto-type. Textron won a 1990 competition and is now the sole contractor. They are continuing development and testing, with type classification scheduled for 3rd quarter FY96.

The Hornet is about to enter low-rate production and will be fielded at Fort Bragg beginning in July 1998.



The Hornet

How the Hornet Works

The Hornet is a 35-pound munition designed to detect, identify, track, engage, and defeat moving targets up to T-80 class tanks at ranges up to 100 meters. It can be armed manually or remotely by the M71 Modular Pack Mine System remote control unit.

Before emplacement, the soldier removes the Hornet's active battery from the shipping container and inserts it for circuit testing. The Hornet comes with the main reserve cell battery embedded in the munition, and it is not activated until final arming. Also before emplacement, manual or remote arming is determined, the target switch is set (to attack only heavy, tracked vehicles, or all tracked vehicles), and a self-destruct time is selected. The four standard family of scatterable mines self-destruct times (4 hours, 48 hours, 5 days, or 15 days) are available, as well as a 30-day self-destruct time.

The soldier exits the area after emplacing and throwing the arm-enable switch and before the end of the safe separation time. For manual arming, the safe separation time is 5-6 minutes, after which time the Hornet will automatically arm. For remote arming, the safe separation time is 30-36 minutes. At the end of the safe separation time (either manual or remote), micro-detonators sever the cable holding the Hornet's eight legs in place, and the munition snaps upright. This visual cue (a Hornet with legs deployed) indicates that it is armed or at least no longer safe to approach. A remote arm command may be sent up to 60 days after the arm-enable switch is thrown.

An armed Hornet goes to power cycling "sleep" mode until the geophone seismic sensor detects a potential target, usually at ranges of up to 600 meters. This alerts the munition to start listening with its three microphones, which are also deployed at legs-down. The Hornet tracks the two loudest noise sources it hears and attacks the louder of the two when it reaches the closest point of approach to the munition.

Before the Hornet attacks, ground platform electronics go through a sophisticated analysis and decision process to ensure the submunition is properly pro-grammed to engage the target. It determines if the target is moving left-to-right or right-to-left, is wheeled or tracked, and is heavy or light. (The Hornet does not engage targets under 5 metric tons.) Hornets currently attack only tracked vehicles, but follow-on variants will engage heavy, wheeled vehicles as well. If the target is a tank, the Hornet determines if it is a diesel or turbine tank, and if it is a Russian-style tank with the exhaust port over the left rear deck. In each case, the hot spot that the submunition's infrared sensor sees is at a different offset from the engine deck (rear for diesel, left rear for Russian, and in the exhaust plume for a turbine).

Properly programmed, the submunition launches like a skeet at a 30-degree angle. It precesses (wobbles) as it flies out so it can scan the ground in overlapping circles. Fly-out time to the 100-meter range is about 3-4 seconds. Once over the target, the sub-munition fires its explosively formed penetrator warhead at the appropriate offset from the vehicle hot spot to achieve a mobility kill. The warhead can penetrate any vehicle on the rear deck and most on the turret roof.

Not a Mine

The Hornet began as a sophisticated off-route, reinforcing mine. But after study, it became clear that it was more correctly a short-range, autonomous antiarmor system-a robot with a shoulder-fired anti-tank weapon. The difference is explained below.

The original Hornet concept was to kill breaching vehicles as they led an attack through conventional or scatterable minefields. Hornets would be laid in front of these minefields to achieve this effect. The TRADOC Analysis Command confirmed this as useful but also identified better uses.

In a march to contact or meeting engagement situation, an enemy force will use roads to maximize speed. Hornets em-ployed in clusters of 3-6 munitions will disrupt this movement by causing casualties and

throwing off timing and coordination. This tactic is called the *gauntlet*. One refinement is to switch deeper gauntlet clusters to detonate tanks only, so lighter reconnaissance vehicles will falsely report the route as clear. Once committed to the route, tanks encounter these clusters while the reconnaissance vehicles encounter attacks by later clusters. A second refinement is to use this tactic in conjunction with the layout of the road network to influence the enemy commander's route selection. This use elevates engineer operations to the direct attack of enemy planning and execution at regimental and divisional echelons.

A third use of the Hornet was determined in modeling at the U.S. Army Engineer School by ex-amining enemy movements be-tween his approach march and assault formations. At 5 kilometers or one terrain feature from our positions, Russian doctrine requires regiments and battalions to change from column of march to column of companies and column of platoons. In this scenario, Hornets are laid in a large "X" pattern (a kilometer on each side) to disrupt this prebattle activity as the enemy changes formations (see figure). This causes casualties and confusion at a critical timing point in the area where the regimental artillery group will set up to support the attack.

These uses of the Hornet are impossible (or logistically prohibitive) for conventional and scatterable mines. And while the Hornet can be used to install a linear obstacle, the munition's 100-meter range is as much of a liability as an asset. When one enemy vehicle breaks clear of a minefield, it might leave a 4-meter path; but when one enemy vehicle clears a WAM obstacle, it clears a much wider swath.

The Hornet undergoes extensive deveopment testing at Yuma Proving Ground, Arizona, to sub design responsibility.

Characteristics

The Hornet is a first-generation, autonomous, smart antiarmor munition. Its unique capabilities allow it to be employed in a variety of missions:

Performance.

- Attacks valid targets to ranges of 100 meters, and any target approaching within 15 meters.
- Can be placed on slopes of up to 15 degrees on almost any soil and surface type.

Other Characteristics.

- Contains no explosives in the ground-platform modules. Launch is by a chemical gas generator. If disturbed, the Hornet will quick-fire and the sublet will detonate immediately on launch. In all cases, the ground-platform electronics will burn themselves out on launch to preclude intelligence use if captured.
- Can be transported by truck, ship, or aircraft. It is externally transportable by helicopter but is not yet certified for airdrop. A single C-141 aircraft can carry 1,080 Hornets.
- Is survivable in severe climatic and chemical environments and is not affected by a high-altitude electromagnetic pulse. The Hornet is certified decontaminable only before removal from its storage container.
- Can operate in all weather conditions. However, its sensors are somewhat affected by weather conditions, such as rain, snow, and very heavy fog, that weaken sound and thermal signatures.

Training and Doctrine

Beginning in 1997, the combat training centers will receive the M97 collective training device. In 1998, the M93 hand-emplaced WAM will be fielded, and the training support centers will receive the M98 individual training device. The M98s will be fielded in sets of 20 to support platoon-level training on the emplacement of multiple gauntlet clusters and single-area disruption patterns. Squads can emplace individual gauntlet clusters, but emplacing multiple gauntlet clusters and single-area disruption patterns is a platoon mission.

Hornet emplacement will be a 12B10 common task. Institutional training for soldiers and leaders will begin in FY97. Supervisory tasks will be taught in the Basic Noncommissioned Officer Course, while leaders will learn Hornet tactics, techniques, and procedures in the Engineer Officer Basic and Advanced Courses.

The following doctrinal publications will be revised to include Hornet information: FM 20-32, *Mine/Countermine Operations*; FM 90-7, *Combined Arms Obstacle Integration;* FM 5-100, *Engineer Operations;* and FM 5-71-100, *Division Engineer Combat Operations.*

Command and control measures will parallel those required for hand-emplaced mines. Final decisions will depend on Standardized North Atlantic Treaty Organization Agreements (STANAGs) currently under discussion. The draft STANAG requires a form similar to the DA Form 1355 that shows the position of each Hornet and an outline of the 100-meter lethal area(s) encompassed by them. Emplacement authority resides at Corps until delegated.

The Future

Development has begun on the product improvement program (PIP) Hornet. The PIP adds two-way communication over a single-channel, ground-to-air radio system (SINCGARS) to an Army common hardware computer control unit, with a line-of-sight range of 3-5 kilometers. The PIP Hornet can be turned off and queried to confirm its status. If the legs aren't deployed, it can be picked up and moved to a new location. If they are deployed, the Hornet reports every target it hears to the control unit. Prior to launch, it reports the type of target it is about to attack. A preplanned PIP for a repeater to extend the communication range is scheduled for 4-8 years after fielding of the PIP Hornet.

Development of the intelligent minefield (IMF) begins in 1998. The IMF program will add an acoustic

overwatch sensor, long-haul communication capability, and local computer control to the emplaced Hornets to coordinate such actions as when and what targets to engage.

An IMF can report the individual targets identified by the Hornets, approaching aircraft and personnel, and the composition and direction of enemy formations. An IMF can wait until the middle of a column to attack, and can call for reinforcing fires. It can also adjust these fires for maximum effect. Employed autonomously, the IMF can participate in counterreconnaissance, guard open flanks, or cover tactical risk areas. When emplaced deep, the IMF can cue deep strikes by artillery or air, adjust artillery fires, and report subsequent enemy presence to assess battle damage or cue follow-on strikes. Development of a dedicated deep-attack WAM variant will begin in 2000.

The Hornet is the Corps of Engineers' premier munition system. It gives maneuver commanders greater flexibility on the battlefield, allowing engineers to better support the countermobility mission. The Hornet helps to free overtasked engineer resources for more efficient use on high-priority combat missions. In short, the Hornet provides U.S. forces with a significant advantage over opposing forces. It can support and influence direct- and indirect-fire battles as well as influence enemy decision-making, timetables, and maneuver at the regimental and divisional levels. The Hornet adds another dimension to the battlefield and expands the parameters of control and influence that affect the flow of battle.

Major Fields is the chief of the Mines Branch, TRADOC System Manager, Engineer Combat Systems. Previous assignments include Facility Construction Research and Development Officer and Assistant Project Manager for the Sense and Destroy Armor (SADARM) Program, both at Picatinny Arsenal, New Jersey. A graduate of the Command and General Staff College, Major Fields holds a bachelor of science degree in mechanical engineering from Alabama Agricultural and Mechanical University and a bachelor of science in aerospace engineering from Georgia Institute of Technology.

[Top] [Prev] [Next] [Bottom]

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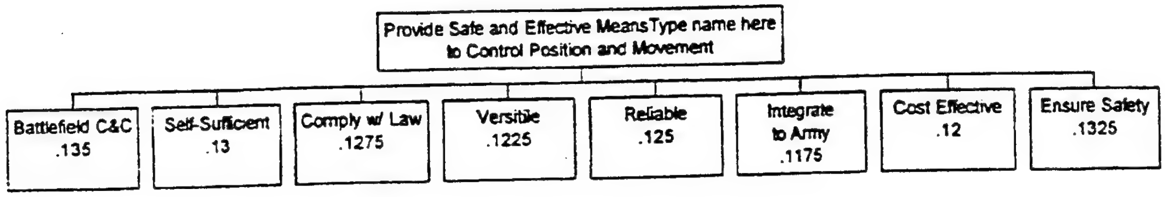
euhanksc@wood.army.mil

Appendix E - Alternative Technologies to Anti-Personnel Landmines

Weighted Objectives Tree



Measures of Effectiveness

	Criteria
Cost to deny area	Operational $ to deny and Area 10 km x 10 km
Expected time to field	The time in years to field the alternative, starting at present
Mean time between failures	The average time in hours between system failures
Size of footprint	Size in square km.
Life Span	Life span of the alternative in years: at ≥95% reliability
Probability a unit is detected	Fraction of enemy units detected
Probability a unit is stopped	Fraction of enemy units stopped
Penetration percent	Given the enemy is stopped, what percentage of the area on average did he penetrate
Number of enemy killed	How many enemy kills were recorded per attack

Feasibility Screening Matrix

Alternative	Cost	Safe	Humane	Failure Rate	Radius of Kill	Env. Concerns	Tech. Available	Research Available	Go/NoGo
Electricity	High	No	No	High	Zero	Yes	No	Little	No Go
Chemical	High	No	No	High	Low	Yes	No	Little	No Go
EMP	Med	Yes	Yes	Variable	High	No	Yes	Little	Go
Satellite	Med	Yes	Yes	Low	High	No	Yes	Yes	Go
Remote Sensors	Low	Yes	Yes	Not Known	Low	Little	Yes	Little	Go
UAV	High	Yes	Yes	High	High	No	Yes	Yes	Go
IWAM	Med	Yes	Yes	Moderate	Low	No	Yes	Yes	Go

Analytical Tools Used in Evaluating Alternative Technologies (Example)[1]

[1] Steve Douglas and others, 9-20.

United Nations: Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Anti-Personnel Mines and on their Destruction[1]

[1] I.L.M., Volume 36, Number 6 (November, 1997)

International Legal Materials

Volume 36, Number 6

November, 1997

36 I.L.M. 1507; (1997)

SECTION: TREATIES AND AGREEMENTS

UNITED NATIONS: **CONVENTION ON THE PROHIBITION** OF THE USE, **STOCKPILING, PRODUCTION AND TRANSFER OF ANTI-PERSONNEL** MINES AND ON THEIR DESTRUCTION *

* [Reproduced from the text provided by the Government of Canada. Some ninety States were full participants in the negotiations and thirty States attended as observers, as did representatives of the International Committee of the Red Cross (ICRC), the International Federation of Red Cross and Red Crescent Societies, the United Nations and the International (NGO) Campaign to Ban **Landmines. The Convention** will be open for signature at Ottawa, Canada, by all States from December 3, 1997 until December 4, 1997, and at the United Nations Headquarters in New York from December 5, 1997 until its entry into force. The **Convention** will enter into force on the first day of the sixth month after the month in which the 40th instrument of ratification, acceptance, approval or accession has been deposited with the Secretary-General of the United Nations.

[The Protocol on **Prohibitions** or Restrictions on the Use of Mines, Booby-Traps and Other Devices, as amended on May 3, 1996 and annexed to the **Convention on Prohibitions** or Restrictions on the Use of Certain Conventional Weapons Which May be Deemed to be Excessively injurious or to Have Indiscriminate Effects, appears at 35 I.L.M. 1206 (1996); The Final Act of the UN Conference on **Prohibitions** or Restrictions on the Use of Certain Conventional Weapons which May be Deemed to be Excessively Injurious or to Have Indiscriminate Effects and the **Convention,** done at Geneva on October 10, 1980, appear at 19 I.L.M. 1523 (1980).

[For additional information, contact the UN Treaty Section, Office of Legal Affairs, Secretariat Building S3200, UN Headquarters, New York, NY 10017, U.S.A. (tel.: 212 963 5047; fax: 212 963 3693).]

DATE: September 18, 1997, Adopted at Oslo

LENGTH: 5690 words

INTRODUCTION:

TEXT:

[*1509] 18 September 1997

CONVENTION ON THE PROHIBITION OF THE USE, **STOCKPILING, PRODUCTION AND TRANSFER OF ANTI-PERSONNEL** MINES AND ON THEIR DESTRUCTION

Preamble

The States Parties,

Determined to put an end to the suffering and casualties caused by **anti-personnel** mines, that kill or maim hundreds of people every week, mostly innocent and defenceless civilians and especially children, obstruct economic development and reconstruction, inhibit the repatriation of refugees and

internally displaced persons, and have other severe consequences for years after emplacement,

Believing it necessary to do their utmost to contribute in an efficient and coordinated manner to face the challenge of removing **anti-personnel** mines placed throughout the world, and to assure their destruction,

Wishing to do their utmost in providing assistance for the care and rehabilitation, including the social and economic reintegration of mine victims,

Recognizing that a total ban of **anti-personnel** mines would also be an important confidence-building measure,

Welcoming the adoption of the Protocol on **Prohibitions** or Restrictions on the Use of Mines, Booby-Traps and Other Devices, as amended on 3 May 1996, annexed to the **Convention on Prohibitions** or Restrictions on the Use of Certain Conventional Weapons Which May Be Deemed to Be Excessively Injurious or to Have Indiscriminate Effects, and calling for the early ratification of this Protocol by all States which have not yet done so,

Welcoming also United Nations General Assembly Resolution 51/45 S of 10 December 1996 urging all States to pursue vigorously an effective, legally-binding international agreement to ban the use, **stockpiling, production and transfer of anti-personnel landmines,**

Welcoming furthermore the measures taken over the past years, both unilaterally and multilaterally, aiming at prohibiting, restricting or suspending the use, **stockpiling, production and transfer of anti-personnel** mines,

Stressing the role of public conscience in furthering the principles of humanity as evidenced by the call for a total ban of **anti-personnel** mines and recognizing the efforts to that end undertaken by the International Red Cross and Red Crescent Movement, the International Campaign to Ban **Landmines** and numerous other non-governmental organizations around the world,

Recalling the Ottawa Declaration of 5 October 1996 and the Brussels Declaration of 27 June 1997 urging the international community to negotiate an international and legally binding agreement prohibiting the use, **stockpiling, production and transfer of anti-personnel** mines,

Emphasizing the desirability of attracting the adherence of all States to this **Convention,** and determined to work strenuously towards the promotion of its universalization in all relevant fora including, inter alia, the United Nations, the Conference on Disarmament, regional organizations, and groupings, and review conferences of the **Convention on Prohibitions** or Restrictions on the Use of Certain Conventional Weapons Which May Be Deemed to Be Excessively Injurious or to Have Indiscriminate Effects,

Basing themselves on the principle of international humanitarian law that the right of the parties to an armed conflict to choose methods or means of warfare is not unlimited, on the principle that prohibits the employment in armed conflicts of weapons, projectiles and materials and methods of warfare of a nature to cause [*1510] superfluous injury or unnecessary suffering and on the principle that a distinction must be made between civilians and combatants,
Have agreed as follows:

Article 1

General obligations

1. Each State Party undertakes never under any circumstances:

a) To use **anti-personnel** mines;

b) To develop, produce, otherwise acquire, stockpile, retain or **transfer** to anyone, directly or indirectly, **anti-personnel** mines;

c) To assist, encourage or induce, in any way, anyone to engage in any activity prohibited to a State Party under this **Convention.**

2. Each State Party undertakes to destroy or ensure the destruction of all **anti-personnel** mines in accordance with the provisions of this **Convention.**

Article 2

Definitions

1. "**Anti-personnel** mine" means a mine designed to be exploded by the presence, proximity or contact of a person and that will incapacitate, injure or kill one or more persons. Mines designed to be detonated by the presence, proximity or contact of a vehicle as opposed to a person, that are equipped with anti-handling devices, are not considered **anti-personnel** mines as a result of being so equipped.
2. "Mine" means a munition designed to be placed under, on or near the ground or other surface area and to be exploded by the presence, proximity or contact of a person or a vehicle.
3. "Anti-handling device" means a device intended to protect a mine and which is part of, linked to, attached to or placed under the mine and which activates when an attempt is made to tamper with or otherwise intentionally disturb the mine.
4. "**Transfer**" involves, in addition to the physical movement of **anti-personnel** mines into or from national territory, the **transfer** of title to and control over the mines, but does not involve the **transfer** of territory containing emplaced **anti-personnel** mines.
5. "Mined area" means an area which is dangerous due to the presence or suspected presence of mines.

Article 3

Exceptions

1. Notwithstanding the general obligations under Article 1, the retention or **transfer** of a number of **anti-personnel** mines for the development of and training in mine detection, mine clearance, or mine destruction techniques is permitted. The amount of such mines shall not exceed the minimum number absolutely necessary for the above-mentioned purposes.
2. The **transfer of anti-personnel** mines for the purpose of destruction is permitted.

Article 4

Destruction of stockpiled **anti-personnel** mines

Except as provided for in Article 3, each State Party undertakes to destroy or ensure the destruction of all stockpiled **anti-personnel** mines it owns or possesses, or that are [*1511] under its jurisdiction or control, as soon as possible but not later than four years after the entry into force of this **Convention** for that State Party.

Article 5

Destruction of **anti-personnel** mines in mined areas

1. Each State Party undertakes to destroy or ensure the destruction of all **anti-personnel** mines in mined areas under its jurisdiction or control, as soon as possible but not later than ten years after the entry into force of this **Convention** for that State Party.
2. Each State Party shall make every effort to identify all areas under its jurisdiction or control in which **anti-personnel** mines are known or suspected to be emplaced and shall ensure as soon as possible that all **anti-personnel** mines in mined areas under its jurisdiction or control are perimeter-marked, monitored and protected by fencing or other means, to ensure the effective exclusion of civilians, until all **anti-personnel** mines contained therein have been destroyed. The marking shall at least be to the standards set out in the Protocol on **Prohibitions** or Restrictions on the Use of Mines, Booby-Traps and Other Devices, as amended on 3 May 1996, annexed to the **Convention on Prohibitions** or Restrictions on the Use of Certain Conventional Weapons Which May Be Deemed to Be Excessively Injurious or to Have Indiscriminate Effects.

3. If a State Party believes that it will be unable to destroy or ensure the destruction of all **anti-personnel** mines referred to in paragraph 1 within that time period, it may submit a request to a Meeting of the States Parties or a Review Conference for an extension of the deadline for completing the destruction of such **anti-personnel** mines, for a period of up to ten years.
4. Each request shall contain:
a) The duration of the proposed extension;
b) A detailed explanation of the reasons for the proposed extension, including:
(i) The preparation and status of work conducted under national detaining programs;
(ii) The financial and technical means available to the State Party for the destruction of all the **anti-personnel** mines; and
(iii) Circumstances which impede the ability of the State Party to destroy all the **anti-personnel** mines in mined areas;

c) The humanitarian, social, economic, and environmental implications of the extension; and
d) Any other information relevant to the request for the proposed extension.
5. The Meeting of the States Parties or the Review Conference shall, taking into consideration the factors contained in paragraph 4, assess the request and decide by a majority of votes of States Parties present and voting whether to grant the request for an extension period.
6. Such an extension may be renewed upon the submission of a new request in accordance with paragraphs 3, 4 and 5 of this Article. In requesting a further extension period a State Party shall submit relevant additional information on what has been undertaken in the previous extension period pursuant to this Article.

Article 6

International cooperation and assistance
1. In fulfilling its obligations under this **Convention** each State Party has the right to seek and receive assistance, where feasible, from other States Parties to the extent possible.
[*1512] 2. Each State Party undertakes to facilitate and shall have the right to participate in the fullest possible exchange of equipment, material and scientific and technological information concerning the implementation of this **Convention.** The States Parties shall not impose undue restrictions on the provision of mine clearance equipment and related technological information for humanitarian purposes.
3. Each State Party in a position to do so shall provide assistance for the care and rehabilitation, and social and economic reintegration, of mine victims and for mine awareness programs. Such assistance may be provided, inter alia, through the United Nations system, international, regional or national organizations or institutions, the International Committee of the Red Cross, national Red Cross and Red Crescent societies and their International Federation, non-governmental organizations, or on a bilateral basis.
4. Each State Party in a position to do so shall provide assistance for mine clearance and related activities. Such assistance may be provided, inter alia, through the United Nations system, international or regional organizations or institutions, non-governmental organizations or institutions, or on a bilateral basis, or by contributing to the United Nations Voluntary Trust Fund for Assistance in Mine Clearance, or other regional funds that deal with demining.
5. Each State Party in a position to do so shall provide assistance for the destruction of stockpiled **anti-personnel** mines.
6. Each State Party undertakes to provide information to the database on mine clearance established within the United Nations system, especially information concerning various means and technologies of mine clearance, and lists of experts, expert agencies or national points of contact on mine clearance.
7. States Parties may request the United Nations, regional organizations, other States Parties or other competent intergovernmental or non-governmental fora to assist its authorities in the elaboration of a national demining program to determine, inter alia:
a) The extent and scope of the **anti-personnel** mine problem;

b) The financial, technological and human resources that are required for the implementation of the program;
c) The estimated number of years necessary to destroy all **anti-personnel** mines in mined areas under the jurisdiction or control of the concerned State Party;
d) Mine awareness activities to reduce the incidence of mine-related injuries or deaths;
e) Assistance to mine victims;
f) The relationship between the Government of the concerned State Party and the relevant governmental, inter-governmental or non-governmental entities that will work in the implementation of the program.
8. Each State Party giving and receiving assistance under the provisions of this Article shall cooperate with a view to ensuring the full and prompt implementation of agreed assistance programs.

Article 7

Transparency measures
1. Each State Party shall report to the Secretary-General of the United Nations as soon as practicable, and in any event not later than 180 days after the entry into force of this **Convention** for that State Party on:
a) The national implementation measures referred to in Article 9;
b) The total of all stockpiled **anti-personnel** mines owned or possessed by it, or under its jurisdiction or control, to include a breakdown of the type, quantity and, if possible, lot numbers of each type of **anti-personnel** mine stockpiled;
[*1513] c) To the extent possible, the location of all mined areas that contain, or are suspected to contain, **anti-personnel** mines under its jurisdiction or control, to include as much detail as possible regarding the type and quantity of each type of **anti-personnel** mine in each mined area and when they were emplaced;
d) The types, quantities and, if possible, lot numbers of all **anti-personnel** mines retained or transferred for the development of and training in mine detection, mine clearance or mine destruction techniques, or transferred for the purpose of destruction, as well as the institutions authorized by a State Party to retain or **transfer anti-personnel** mines, in accordance with Article 3;
e) The status of programs for the conversion or de-commissioning of **anti-personnel** mine **production** facilities;
f) The status of programs for the destruction of **anti-personnel** mines in accordance with Articles 4 and 5, including details of the methods which will be used in destruction, the location of all destruction sites and the applicable safety and environmental standards to be observed;
g) The types and quantities of all **anti-personnel** mines destroyed after the entry into force of this **Convention** for that State Party, to include a breakdown of the quantity of each type of **anti-personnel** mine destroyed, in accordance with Articles 4 and 5, respectively, along with, if possible, the lot numbers of each type of **anti-personnel** mine in the case of destruction in accordance with Article 4;
h) The technical characteristics of each type of **anti-personnel** mine produced, to the extent known, and those currently owned or possessed by a State Party, giving, where reasonably possible, such categories of information as may facilitate identification and clearance of **anti-personnel** mines; at a minimum, this information shall include the dimensions, fusing, explosive content, metallic content, colour photographs and other information which may facilitate mine clearance; and
i) The measures taken to provide an immediate and effective warning to the population in relation to all areas identified under paragraph 2 of Article 5.
2. The information provided in accordance with this Article shall be updated by the States Parties annually, covering the last calendar year, and reported to the Secretary-General of the United Nations not later than 30 April of each year.
3. The Secretary-General of the United Nations shall transmit all such reports received to the States Parties.

Article 8

Facilitation and clarification of compliance

1. The States Parties agree to consult and cooperate with each other regarding the implementation of the provisions of this **Convention,** and to work together in a spirit of cooperation to facilitate compliance by States Parties with their obligations under this **Convention.**

2. If one or more States Parties wish to clarify and seek to resolve questions relating to compliance with the provisions of this **Convention** by another State Party, it may submit, through the Secretary-General of the United Nations, a Request for Clarification of that matter to that State Party. Such a request shall be accompanied by all appropriate information. Each State Party shall refrain from unfounded Requests for Clarification, care being taken to avoid abuse. A State Party that receives a Request for Clarification shall provide, through the Secretary-General of the United Nations, within 28 days to the requesting State Party all information which would assist in clarifying this matter.

3. If the requesting State Party does not receive a response through the Secretary-General of the United Nations within that time period, or deems the response to the Request for Clarification to be unsatisfactory, it may submit the matter through the [*1514] Secretary-General of the United Nations to the next Meeting of the States Parties. The Secretary-General of the United Nations shall transmit the submission, accompanied by all appropriate information pertaining to the Request for Clarification, to all States Parties. All such information shall be presented to the requested State Party which shall have the right to respond.

4. Pending the convening of any meeting of the States Parties, any of the States Parties concerned may request the Secretary-General of the United Nations to exercise his or her good offices to facilitate the clarification requested.

5. The requesting State Party may propose through the Secretary-General of the United Nations the convening of a Special Meeting of the States Parties to consider the matter. The Secretary-General of the United Nations shall thereupon communicate this proposal and all information submitted by the States Parties concerned, to all States Parties with a request that they indicate whether they favour a Special Meeting of the States Parties, for the purpose of considering the matter. In the event that within 14 days from the date of such communication, at least one-third of the States Parties favours such a Special Meeting, the Secretary-General of the United Nations shall convene this Special Meeting of the States Parties within a further 14 days. A quorum for this Meeting shall consist of a majority of States Parties.

6. The Meeting of the States Parties or the Special Meeting of the States Parties, as the case may be, shall first determine whether to consider the matter further, taking into account all information submitted by the States Parties concerned. The Meeting of the States Parties or the Special Meeting of the States Parties shall make every effort to reach a decision by consensus. If despite all efforts to that end no agreement has been reached, it shall take this decision by a majority of States Parties present and voting.

7. All States Parties shall cooperate fully with the Meeting of the States Parties or the Special Meeting of the States Parties in the fulfilment of its review of the matter, including any fact-finding missions that are authorized in accordance with paragraph 8.

8. If further clarification is required, the Meeting of the States Parties or the Special Meeting of the States Parties shall authorize a fact-finding mission and decide on its mandate by a majority of States Parties present and voting. At any time the requested State Party may invite a fact-finding mission to its territory. Such a mission shall take place without a decision by a Meeting of the States Parties or a Special Meeting of the States Parties to authorize such a mission. The mission, consisting of up to 9 experts, designated and approved in accordance with paragraphs 9 and 10, may collect additional information on the spot or in other places directly related to the alleged compliance issue under the jurisdiction or control of the requested State Party.

9. The Secretary-General of the United Nations shall prepare and update a list of the names, nationalities and other relevant data of qualified experts provided by States Parties and communicate it to all States Parties. Any expert included on this list shall be regarded as designated for all fact-finding

missions unless a State Party declares its non-acceptance in writing. In the event of non-acceptance, the expert shall not participate in fact-finding missions on the territory or any other place under the jurisdiction or control of the objecting State Party, if the non-acceptance was declared prior to the appointment of the expert to such missions.

10. Upon receiving a request from the Meeting of the States Parties or a Special Meeting of the States Parties, the Secretary-General of the United Nations shall, after consultations with the requested State Party, appoint the members of the mission, including its leader. Nationals of States Parties requesting the fact-finding mission or directly affected by it shall not be appointed to the mission. The members of the fact-finding mission shall enjoy privileges and immunities under Article VI of the Convention on the Privileges and Immunities of the United Nations, adopted on 13 February 1946.

11. Upon at least 72 hours notice, the members of the fact-finding mission shall arrive in the territory of the requested State Party at the earliest opportunity. The requested State Party shall take the necessary administrative measures to receive, transport and accommodate the mission, and shall be responsible for ensuring the security of the mission to the maximum extent possible while they are on territory under its control.

[*1515] 12. Without prejudice to the sovereignty of the requested State Party, the fact-finding mission may bring into the territory of the requested State Party the necessary equipment which shall be used exclusively for gathering information on the alleged compliance issue. Prior to its arrival, the mission will advise the requested State Party of the equipment that it intends to utilize in the course of its fact-finding mission.

13. The requested State Party shall make all efforts to ensure that the fact-finding mission is given the opportunity to speak with all relevant persons who may be able to provide information related to the alleged compliance issue.

14. The requested State Party shall grant access for the fact-finding mission to all areas and installations under its control where facts relevant to the compliance issue could be expected to be collected. This shall be subject to any arrangements that the requested State Party considers necessary for:

a) The protection of sensitive equipment, information and areas;

b) The protection of any constitutional obligations the requested State Party may have with regard to proprietary rights, searches and seizures, or other constitutional rights; or

c) The physical protection and safety of the members of the fact-finding mission.

In the event that the requested State Party makes such arrangements, it shall make every reasonable effort to demonstrate through alternative means its compliance with this Convention.

15. The fact-finding mission may remain in the territory of the State Party concerned for no more than 14 days, and at any particular site no more than 7 days, unless otherwise agreed.

16. All information provided in confidence and not related to the subject matter of the fact-finding mission shall be treated on a confidential basis.

17. The fact-finding mission shall report, through the Secretary-General of the United Nations, to the Meeting of the States Parties or the Special Meeting of the States Parties the results of its findings.

18. The Meeting of the States Parties or the Special Meeting of the States Parties shall consider all relevant information, including the report submitted by the fact-finding mission, and may request the requested State Party to take measures to address the compliance issue within a specified period of time. The requested State Party shall report on all measures taken in response to this request.

19. The Meeting of the States Parties or the Special Meeting of the States Parties may suggest to the States Parties concerned ways and means to further clarify or resolve the matter under consideration, including the initiation of appropriate procedures in conformity with international law. In circumstances where the issue at hand is determined to be due to circumstances beyond the control of the requested State Party, the Meeting of the States Parties or the Special Meeting of the States Parties may recommend appropriate measures, including the use of cooperative measures referred to in Article 6.

20. The Meeting of the States Parties or the Special Meeting of the States Parties shall make every effort to reach its decisions referred to in paragraphs 18 and 19 by consensus, otherwise by a two-thirds majority of States Parties present and voting.

Article 9

National implementation measures
Each State Party shall take all appropriate legal, administrative and other measures, including the imposition of penal sanctions, to prevent and suppress any activity prohibited to a State Party under this Convention undertaken by persons or on territory under its jurisdiction or control.

[*1516] Article 10

Settlement of disputes
1. The States Parties shall consult and cooperate with each other to settle any dispute that may arise with regard to the application or the interpretation of this Convention. Each State Party may bring any such dispute before the Meeting of the States Parties.
2. The Meeting of the States Parties may contribute to the settlement of the dispute by whatever means it deems appropriate, including offering its good offices, calling upon the States parties to a dispute to start the settlement procedure of their choice and recommending a time-limit for any agreed procedure.
3. This Article is without prejudice to the provisions of this Convention on facilitation and clarification of compliance.

Article 11

Meetings of the States Parties
1. The States Parties shall meet regularly in order to consider any matter with regard to the application or implementation of this Convention, including:
a) The operation and status of this Convention;
b) Matters arising from the reports submitted under the provisions of this Convention;
c) International cooperation and assistance in accordance with Article 6;
d) The development of technologies to clear anti-personnel mines;
e) Submissions of States Parties under Article g; and
f) Decisions relating to submissions of States Parties as provided for in Article 5.
2. The First Meeting of the States Parties shall be convened by the Secretary-General of the United Nations within one year after the entry into force of this Convention. The subsequent meetings shall be convened by the Secretary-General of the United Nations annually until the first Review Conference.
3. Under the conditions set out in Article 8, the Secretary-General of the United Nations shall convene a Special Meeting of the States Parties.
4. States not parties to this Convention, as well as the United Nations, other relevant international organizations or institutions, regional organizations, the International Committee of the Red Cross and relevant non-governmental organizations may be invited to attend these meetings as observers in accordance with the agreed Rules of Procedure.

Article 12

Review Conferences
1. A Review Conference shall be convened by the Secretary-General of the United Nations five years after the entry into force of this Convention. Further Review Conferences shall be convened by the Secretary-General of the United Nations if so requested by one or more States Parties, provided that the interval between Review Conferences shall in no case be less than five years. All States Parties to this Convention shall be invited to each Review Conference.
2. The purpose of the Review Conference shall be:
a) To review the operation and status of this Convention;
b) To consider the need for and the interval between further Meetings of the States Parties referred to in paragraph 2 of Article 11;

[*1517] c) To take decisions on submissions of States Parties as provided for in Article 5; and
d) To adopt, if necessary, in its final report conclusions related to the implementation of this **Convention.**
3. States not parties to this **Convention,** as well as the United Nations, other relevant international organizations or institutions, regional organizations, the International Committee of the Red Cross and relevant non-governmental organizations may be invited to attend each Review Conference as observers in accordance with the agreed Rules of Procedure.

Article 13

Amendments
1. At any time after the entry into force of this **Convention** any State Party may propose amendments to this **Convention.** Any proposal for an amendment shall be communicated to the Depositary, who shall circulate it to all States Parties and shall seek their views on whether an Amendment Conference should be convened to consider the proposal. If a majority of the States Parties notify the Depositary no later than 30 days after its circulation that they support further consideration of the proposal, the Depositary shall convene an Amendment Conference to which all States Parties shall be invited.
2. States not parties to this **Convention,** as well as the United Nations, other relevant international organizations or institutions, regional organizations, the International Committee of the Red Cross and relevant non-governmental organizations may be invited to attend each Amendment Conference as observers in accordance with the agreed Rules of Procedure.
3. The Amendment Conference shall be held immediately following a Meeting of the States Parties or a Review Conference unless a majority of the States Parties request that it be held earlier.
4. Any amendment to this **Convention** shall be adopted by a majority of two-thirds of the States Parties present and voting at the Amendment Conference. The Depositary shall communicate any amendment so adopted to the States Parties.
5. An amendment to this **Convention** shall enter into force for all States Parties to this **Convention** which have accepted it, upon the deposit with the Depositary of instruments of acceptance by a majority of States Parties. Thereafter it shall enter into force for any remaining State Party on the date of deposit of its instrument of acceptance.

Article 14

Costs
1. The costs of the Meetings of the States Parties, the Special Meetings of the States Parties, the Review Conferences and the Amendment Conferences shall be borne by the States Parties and States not parties to this **Convention** participating therein, in accordance with the United Nations scale of assessment adjusted appropriately.
2. The costs incurred by the Secretary-General of the United Nations under Articles 7 and 8 and the costs of any fact-finding mission shall be borne by the States Parties in accordance with the United Nations scale of assessment adjusted appropriately.

Article 15

Signature
This **Convention,** done at Oslo, Norway, on 18 September 1997, shall be open for signature at Ottawa, Canada, by all States from 3 December 1997 until 4 December 1997, and at the United Nations Headquarters in New York from 5 December 1997 until its entry into force.

[*1518] Article 16

Ratification, acceptance, approval or accession
1. This **Convention** is subject to ratification, acceptance or approval of the Signatories.
2. It shall be open for accession by any State which has not signed the **Convention.**

3. The instruments of ratification, acceptance, approval or accession shall be deposited with the Depositary.

Article 17

Entry into force
1. This **Convention** shall enter into force on the first day of the sixth month after the month in which the 40th instrument of ratification, acceptance, approval or accession has been deposited.
2. For any State which deposits its instrument of ratification, acceptance, approval or accession after the date of the deposit of the 40th instrument of ratification, acceptance, approval or accession, this **Convention** shall enter into force on the first day of the sixth month after the date on which that State has deposited its instrument of ratification, acceptance, approval or accession.

Article 18

Provisional application
Any State may at the time of its ratification, acceptance, approval or accession, declare that it will apply provisionally paragraph 1 of Article 1 of this **Convention** pending its entry into force.

Article 19

Reservations
The Articles of this **Convention** shall not be subject to reservations.

Article 20

Duration and withdrawal
1. This **Convention** shall be of unlimited duration.
2. Each State Party shall, in exercising its national sovereignty, have the right to withdraw from this **Convention.** It shall give notice of such withdrawal to all other States Parties, to the Depositary and to the United Nations Security Council. Such instrument of withdrawal shall include a full explanation of the reasons motivating this withdrawal.
3. Such withdrawal shall only take effect six months after the receipt of the instrument of withdrawal by the Depositary. If, however, on the expiry of that six-month period, the withdrawing State Party is engaged in an armed conflict, the withdrawal shall not take effect before the end of the armed conflict.
4. The withdrawal of a State Party from this **Convention** shall not in any way affect the duty of States to continue fulfilling the obligations assumed under any relevant rules of international law.

[*1519] Article 21

Depositary
The Secretary-General of the United Nations is hereby designated as the Depositary of this **Convention.**

Article 22

Authentic texts
The original of this **Convention,** of which the Arabic, Chinese, English, French, Russian and Spanish texts are equally authentic, shall be deposited with the Secretary-General of the United Nations.

Ottawa Treaty Signatories[1]

[1] "Ottawa Treaty Signatories, Convention on the Prohibition of the Use, Stockpiling, Product Transfer of Anti-Personnel Mines and on their Destruction."

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Ottawa Treaty Signatories

Convention on the Prohibition of the Use, Stockpiling, Product Transfer of Anti-Personnel Mines and on their Destruction Con Oslo on 18 September 1997.

As of January 23, 2001: **139 signatories/accessions | 110 ratifications**
See also: The entire text of the Ottawa Treaty

Signatories	Signed/ Acceeded	Ratified
Albania	Sept 8 1998	Feb 29 200
Algeria	Dec 3 1997	
Andorra	Dec 3 1997	June 29 199
Angola	Dec 4 1997	
Antigua and Barbuda	Dec 3 1997	May 3 1999
Argentina	Dec 4 1997	Sept 14 199
Australia	Dec 3 1997	Jan 14 1999
Austria	Dec 3 1997	June 29 199
Bahamas	Dec 3 1997	July 31 199
Bangladesh	May 7 1998	Sept 6 2000
Barbados	Dec 3 1997	Jan 26 1999
Belgium	Dec 3 1997	Sept 4 1998
Belize	Feb 27 1998	April 23 19
Benin	Dec 3 1997	Sept 25 199
Bolivia	Dec 3 1997	June 9 1998
Bosnia Herzegovina	Dec 3 1997	Sept 8 1998
Botswana	Dec 3 1997	March 1 20
Brazil	Dec 3 1997	April 30 19
Brunei Darussalam	Dec 4 1997	
Bulgaria	Dec 3 1997	Sept 4 1998
Burkina Faso	Dec 3 1997	Sept 16 199
Burundi	Dec 3 1997	
Cambodia	Dec 3 1997	July 28 199
Cameroon	Dec 3 1997	
Canada	Dec 3 1997	Dec 3 1997
Cape Verde	Dec 4 1997	
Chad	July 6 1998	May 6 1999
Chile	Dec 3 1997	

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Colombia	Dec 3 1997	Sept 6 2000
Cook Islands	Dec 3 1997	
Costa Rica	Dec 3 1997	March 17 1
Côte d'Ivoire	Dec 3 1997	June, 30 20
Croatia	Dec 4 1997	May 20 199
Cyprus	Dec 4 1997	
Czech Republic	Dec 3 1997	Oct 26 199
Denmark	Dec 4 1997	June 8 1998
Djibouti	Dec 3 1997	May 18 199
Dominica	Dec 3 1997	March 26, 1
Dominican Republic	Dec 3 1997	June 30, 20
Ecuador	Dec 4 1997	April 29 19
El Salvador	Dec 4 1997	Jan 27 1999
Equatorial Guinea	Sept 16 1998	Sept 16 199
Ethiopia	Dec 3 1997	
Fiji	Dec 3 1997	June 10 199
France	Dec 3 1997	July 23 199
Gabon	Dec 3 1997	Sept 8 2000
Gambia	Dec 4 1997	
Germany	Dec 3 1997	July 23 199
Ghana	Dec 4 1997	June 30 200
Greece	Dec 3 1997	
Grenada	Dec 3 1997	Aug 19 199
Guatemala	Dec 3 1997	March 26, 1
Guinea	Dec 4 1997	Oct 8 1998
Guinea-Bissau	Dec 3 1997	
Guyana	Dec 4 1997	
Haiti	Dec 3 1997	
Holy See	Dec 4 1997	Feb 17 199
Honduras	Dec 3 1997	Sept 24 199
Hungary	Dec 3 1997	April 6 199
Iceland	Dec 4 1997	May 5 1999
Indonesia	Dec 4 1997	
Ireland	Dec 3 1997	Dec 3 1997
Italy	Dec 3 1997	April 23 19
Jamaica	Dec 3 1997	July 17 199
Japan	Dec 3 1997	Sept 30 199
Jordan	Aug 11 1998	Nov 13 199
Kenya	Dec 5 1997	Jan 23 2001
Kiribati	Sept 7 2000	Sept 7 2000
Lesotho	Dec 4 1997	Dec 2 1998

Liberia	Dec 23 1999	Dec 23 199
Liechtenstein	Dec 3 1997	Oct 5 1999
Lithuania	Feb 26, 1999	
Luxembourg	Dec 4 1997	June 14 199
Macedonia	Sept 9 1998	Sept 9 1998
Madagascar	Dec 4 1997	Sept 16 199
Malawi	Dec 4 1997	Aug 13 199
Malaysia	Dec 3 1997	April 22, 19
Maldives	Oct 1 1998	Sept 7 2000
Mali	Dec 3 1997	June 2 1998
Malta	Dec 4 1997	
Marshall Islands	Dec 4 1997	
Mauritania	Dec 3 1997	July 26 200
Mauritius	Dec 3 1997	Dec 3 1997
Mexico	Dec 3 1997	June 9 1998
Moldova, Republic of	Dec 3 1997	Sept 8 2000
Monaco	Dec 4 1997	Nov 17 199
Mozambique	Dec 3 1997	Aug 25 199
Namibia	Dec 3 1997	Sept 21 199
Nauru	Aug 7 2000	Aug 7 2000
Netherlands	Dec 3 1997	April 12, 19
New Zealand	Dec 3 1997	Jan 27 1999
Nicaragua	Dec 4 1997	Nov 30 199
Niger	Dec 4 1997	March 23, 1
Niue	Dec 3 1997	April 15 19
Norway	Dec 3 1997	July 9 1998
Panama	Dec 4 1997	Oct 7 1998
Paraguay	Dec 3 1997	Nov 13 199
Peru	Dec 3 1997	June 17 199
Philippines	Dec 3 1997	Jan 10 2000
Poland	Dec 4 1997	
Portugal	Dec 3 1997	Feb 19 199
Qatar	Dec 4 1997	Oct 13 199
Romania	Dec 3 1997	Nov 30 200
Rwanda	Dec 3 1997	June 8, 200
Saint Kitts & Nevis	Dec 3 1997	Dec 2 1998
Saint Lucia	Dec 3 1997	April 13, 19
Saint Vincent & the Grenadines	Dec 3 1997	
Samoa	Dec 3 1997	July 23 199
San Marino	Dec 3 1997	March 18 1
Sao Tome et Principe	April 30 1998	

Senegal	Dec 3 1997	Sept 24 199
Seychelles	Dec 4 1997	June 2, 200
Sierra Leone	July 19 1998	
Slovakia	Dec 3 1997	Feb 25, 199
Slovenia	Dec 3 1997	Oct 27 199
Solomon Islands	Dec 4 1997	Jan 26 1999
South Africa	Dec 3 1997	June 26 199
Spain	Dec 3 1997	Jan 19 1999
Sudan	Dec 4 1997	
Suriname	Dec 4 1997	
Swaziland	Dec 4 1997	Dec 23 199
Sweden	Dec 4 1997	Nov 30 199
Switzerland	Dec 3 1997	March 24 1
Tajikistan	Oct 12 1999	Oct 12 199
Tanzania, United Republic of	Dec 3 1997	Nov 13 200
Thailand	Dec 3 1997	Nov 27 199
Togo	Dec 4 1997	March 9 20
Trinidad & Tobago	Dec 4 1997	April 27 19
Tunisia	Dec 4 1997	July 9 1999
Turkmenistan	Dec 3 1997	Jan 19 1998
Uganda	Dec 3 1997	Feb 25, 199
Ukraine	Feb 24 1999	
United Kingdom	Dec 3 1997	July 31 199
Uruguay	Dec 3 1997	
Vanuatu	Dec 4 1997	
Venezuela	Dec 3 1997	April 14, 19
Yemen	Dec 4 1997	Sept 1 1998
Zambia	Dec 12 1997	
Zimbabwe	Dec 3 1997	June 18 199

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ENTRY INTO FORCE: 1 March 1999, in accordance with article 17 (1)

Note: States may become bound without signature through a one step proc known as accession.

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